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597: Journal Section of the American Society of Heating and Ventilating Engineers

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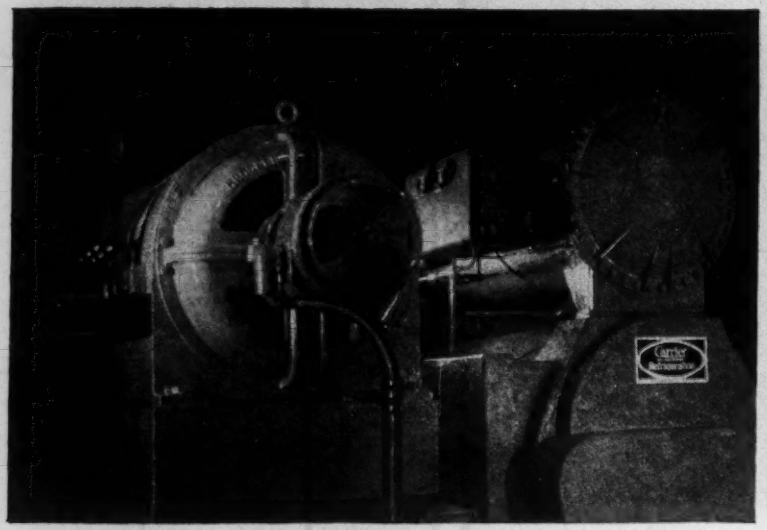
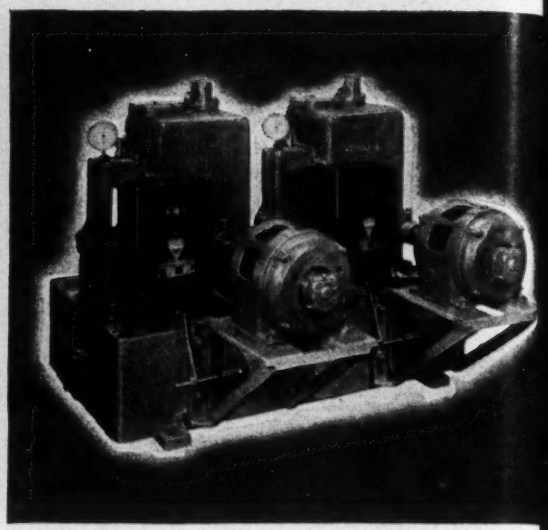
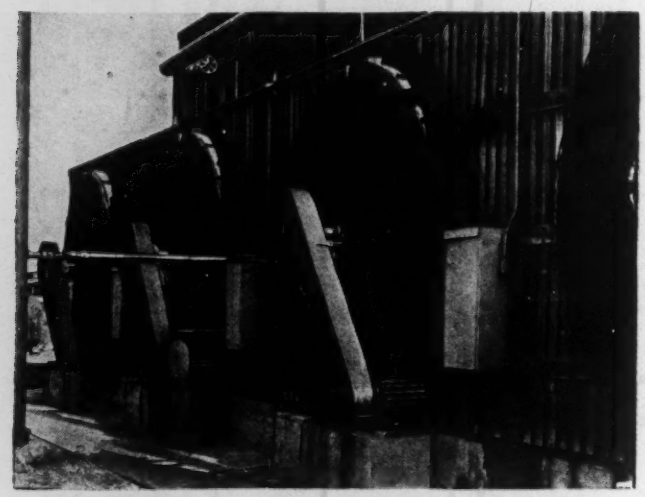
CROCKER-WHEELER POWER for AIR-CONDITIONING EFFICIENCY



One of two 600 ton centrifugal air-conditioning units powered with 500 h.p. Crocker-Wheeler wound rotor motors in one of Washington's leading hotels.



C-W motors powering Chicago Pump Company retur line vacuum and boiler feed pumps for continuous dut



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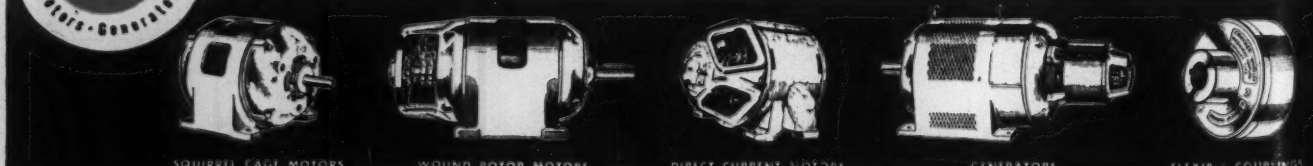

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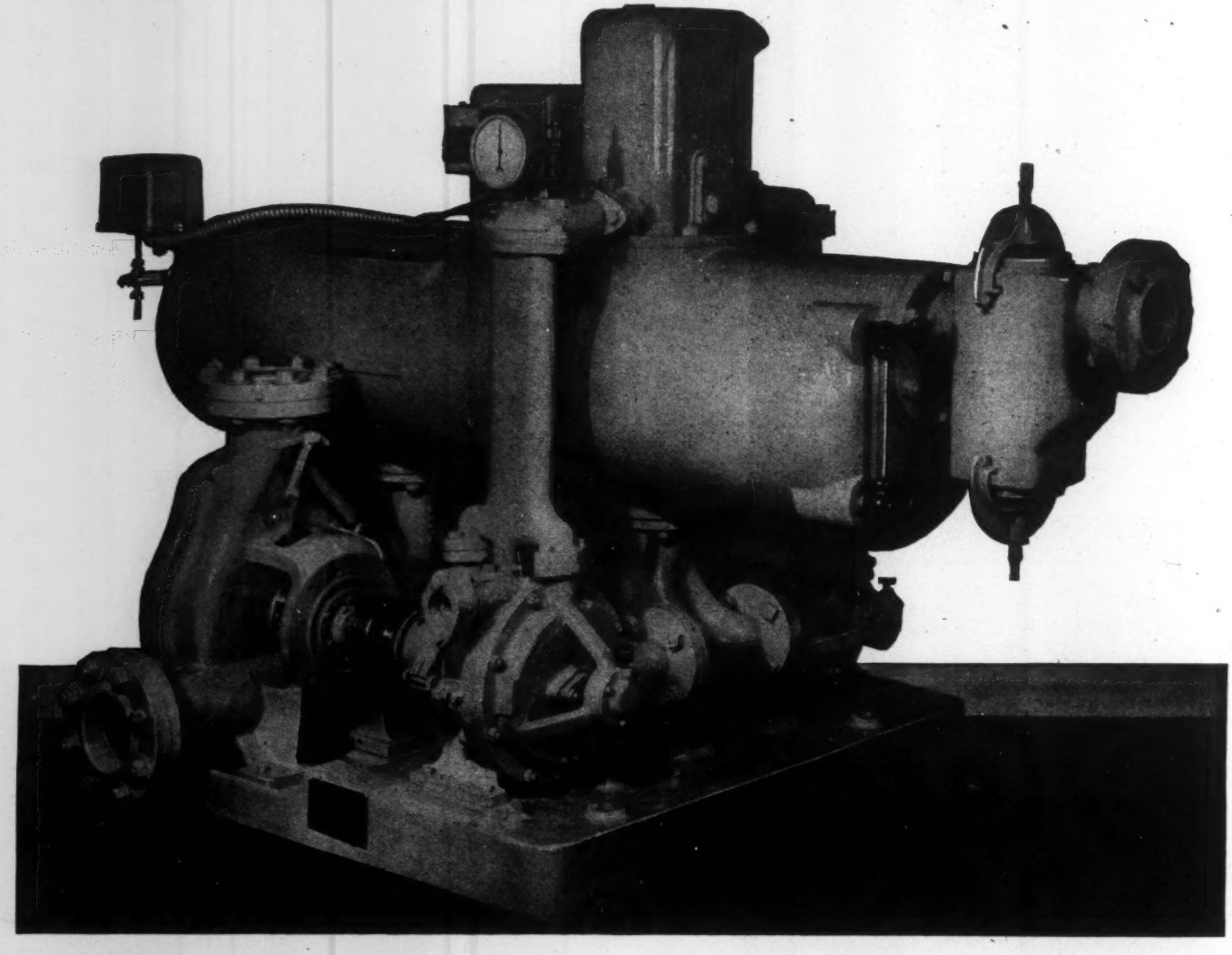
Where Heat Must Not Fail—Install this SAFE Heating Pump!



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BURNING OIL IN WARTIME

Fred Meyer Tells How to Adjust Equipment

There's no fuel like an oil fuel, in the opinion of many engineers and contractors, but for best results the entire oil burning system must be designed and operated as a unit and must be adjusted to suit the particular oil being burned. Here is a practical, up-to-the-minute discussion of the effect of the demands of war on oil viscosity, a summary of why oil viscosities have varied, and an explanation of the method for adjusting burners and other preheating, and control equipment to meet the changes in oil viscosities encountered today . . . Mr. Meyer, combustion engineer with Mid-West Heat Service, has been in industrial oil burner work for some 12 years, including nearly two years with the PAW. His company has installed some of the largest oil burning plants

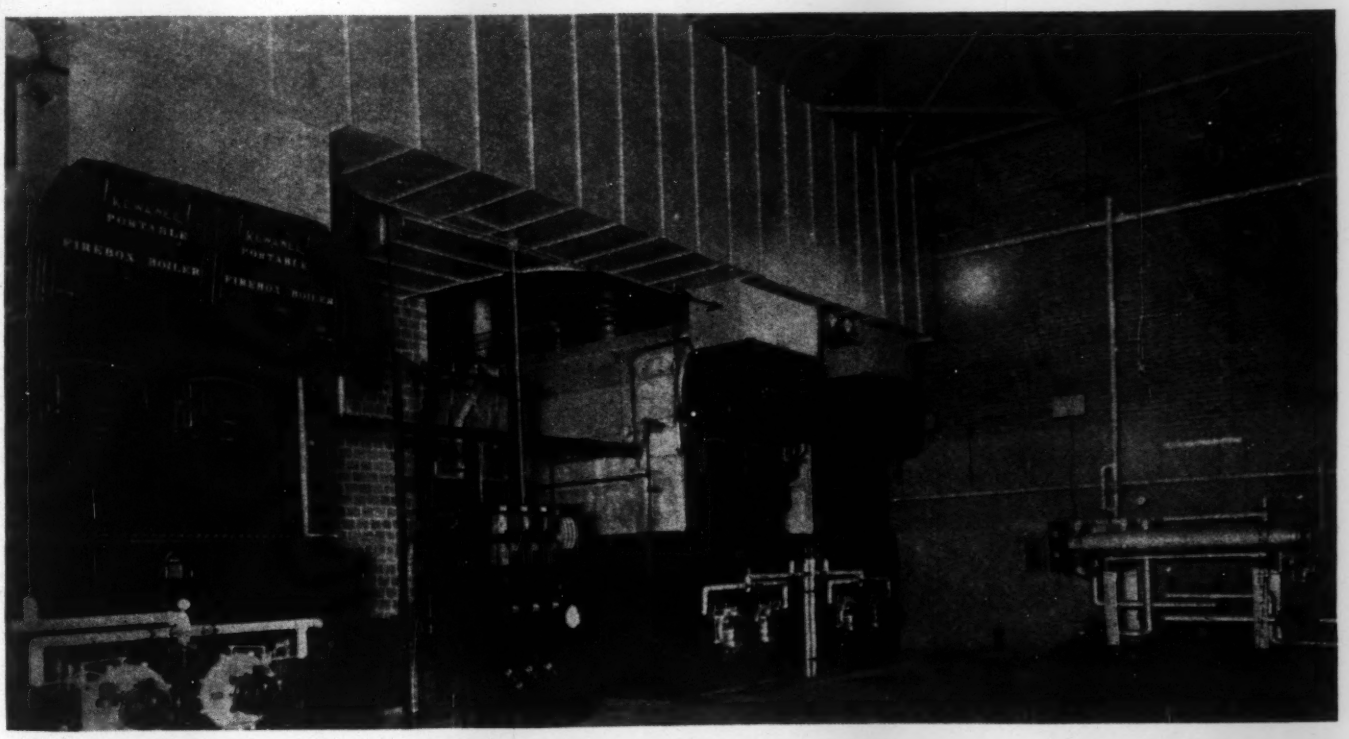
As America approaches her fourth year of worldwide war, users of fuel oils are observing a trend which to the uninformed is highly confusing. To veterans of three years of wartime petroleum distribution, however, confusion is the normal—rather than the abnormal—situation. The reasons for this perplexing dilemma are as varied and as wide in range as the demands to which the petroleum industry has been subjected.

With the start of the defense program in 1940 came the first dislocation of fuel oil supply and demand. Huge new plants, built in hitherto agricultural areas, began to make serious demands on fuel oil supply. This situation was taken by fuel oil suppliers in stride and readjustments in marketing and production were made to handle the new demand.

On December 7, 1941, the national fuel oil position was good, with supply and demand in proper ratio. December and January sinkings of oil tankers plying the route between the Texas oil fields and the eastern seaboard became so serious, however, that tanker shipments to the east coast were stopped altogether. The effect of this action on the eastern states was immediate. Fuel oil shipments to the east by tank car in no wise replaced the lost tanker shipments. The east faced fuel oil rationing and the Petroleum Administration for War instituted the conversion of oil fired facilities to coal as a measure to aid in effecting a balance in the fuel position. It should be noted that at this time the only major factor influencing the supply of fuel oil was lack of adequate distribution. There were not enough tank cars to supply the east and not enough steel (so said the War Production Board) to build more. There was fuel oil available, but transportation facilities to get it into the east were lacking.

Meanwhile, in the Pittsburgh and middle-western steel areas, a

An oil burning system should be designed and operated as a unit



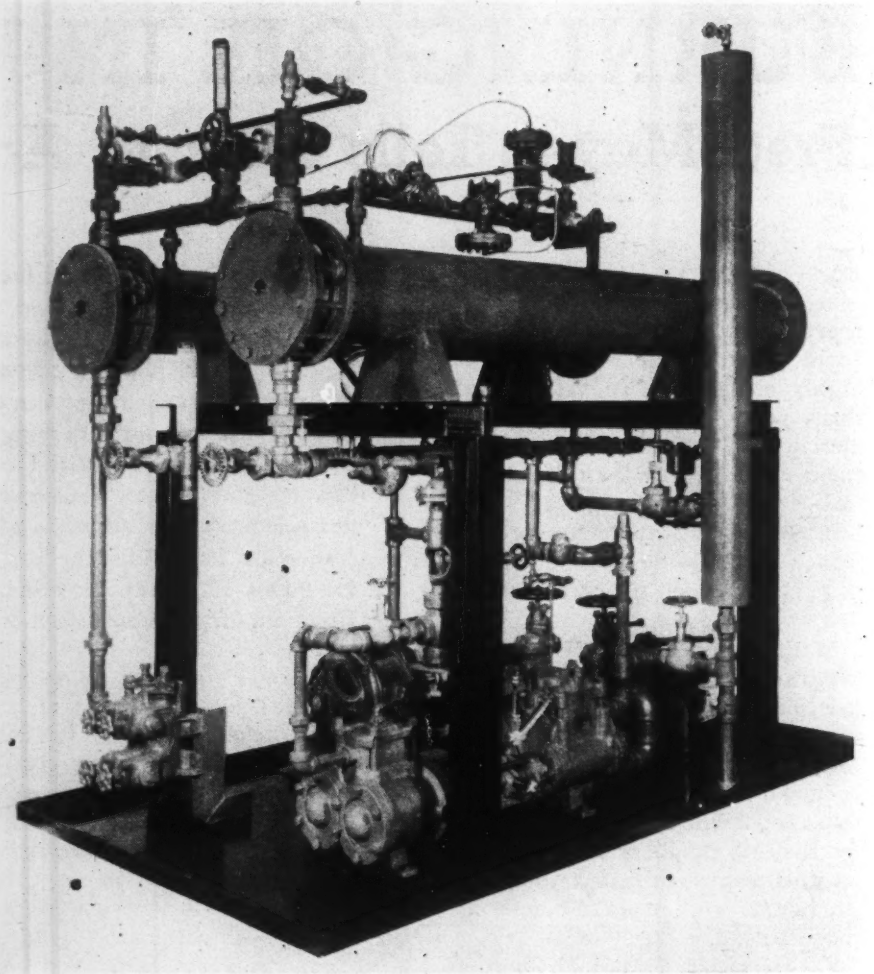
new factor was changing the situation. A demand for steel of all types, unprecedented in world history, was making serious inroads in the supply of residual oils, which are used in steel manufacture. Steel production soared, and with it bunker C oil virtually disappeared from the American market. Even Bessemer furnaces were pressed into service, and residual oil stocks continued to drop.

Other factors, too, added their weight to the already overburdened fuel oil industry. Many units of heavy industry doubled, tripled, and quadrupled production, and then doubled it again. New plants were on the drawing boards or already under construction requiring more oil, and the Navy and the Maritime Commission moved a shipbuilding program into high gear, the size of which was staggering to the imagination. Navy and Maritime demands for residual fuel oil further overbalanced the situation and fuel oil rationing and PAW's conversion program moved into the midwest.

It will be noted that up to this time, the greatest stress was on the heavier, or residual, oils. With the disappearance of bunker C from the market for the many reasons already described, the heaviest load was placed on No. 5 oil. Domestic installations using distillate oils, diesel engines, metallurgical furnaces, bake ovens and the like were rationed, but the supply of fuel oil for these installations, with the exception of the eastern seaboard area, was ample, if not plentiful in most regions. This was September 1942.

Most Burners Out of Adjustment in '42-'43

The effect of this series of changes was to cause many users of fuel oils to employ oils lower in viscosity than any they had used before. With the lower viscosity oils, changes in burner adjustments were necessitated in order to obtain maximum efficiency in combustion. In many areas shipments of oil became more or less unpredictable as far as gravity and viscosity were concerned. This made it necessary to readjust the burners for each delivery of fuel oil with the consequent result that, in more cases than not, the burners were out of adjustment throughout the entire '42-'43 heating season.



Oil pumping, heating, and straining set which was assembled and tested as a unit. Note the duplicate pumps, heaters, and strainers

This was only the beginning of our petroleum difficulties. The world's greatest air force was beginning to form. All over the country parts of planes were streaming to assembly points, there to be fashioned into bombers, fighters, and transports—tens of thousands of them. Fuels having higher octane values than those in use were being developed and as more and still more planes flew, more and better gasolines were being developed to fly them.

Residual oils have always been a "necessary evil" in the manufacture of other, higher revenue-producing, petroleum products. Inherent with the cracking and refining methods in common use was an almost fixed percentage of residual oil for which the only market offered was fuel oil, or road paving.

The development and use of the catalytic cracking process—in which the percentage of residual oils is dropped appreciably, if not dispensed with entirely — would have taken many years under normal conditions. Refining plants are enormously expensive and catalytic plants would have replaced them gradually, only as replacement became an absolute necessity, had it not been for the enormous demand for high octane gasoline created by the war in the air. The demand for this product, however, bridged the handicap of time and catalytic refining plants were immediately put into construction at refining points throughout the nation.

Meanwhile, a host of other factors, favorable and unfavorable, were at work to complicate further an extremely complex situation. "Big Inch" and "Little Inch" were being constructed to help balance the lack of transportation. The need for these lines, one 24 in. and the other 20 in., had been foreseen, but it required a war to bring about their construction. The completion of these lines did much to

get to the east the fuel oils so badly needed there.

The synthetic rubber program, after much tugging and pulling, landed into the lap of the petroleum industry also, and a new demand for petroleum was created. The Navy, too, added another hurdle, with the decision to build thousands of landing craft, diesel powered, for the furtherance of the amphibious type of warfare we were preparing to fight.

WPB consistently refused equipment necessary to the production of new wells, due, it was insisted, to greater need for steel elsewhere. The Office of Price Administration refused to raise the ceiling price of crude oil and thus encourage wildcatting which, at the moment, had sunk to an all time low.

In spite of all this, the petroleum industry continued to deliver, and no acute shortage of oils developed through the '43-'44 heating season. PAW's conversion program, confined in the main to the larger users, had been halted to await further developments. By September 1943 the conversion accomplished plus increased production and increased aid in oil shipments from Venezuela, along with rigid rationing, produced a condition resembling balance. The conversion program affected residual oil users and some distillate oil users. This was due almost entirely to the fact that large users of fuel oils employ residual oils for boilers which are convertible, while distillate oils are used for diesel engines, metallurgical furnaces, and bake ovens which cannot readily be converted to coal.

Thus, although the residual fuel oil picture was improved somewhat, the distillate oil position steadily deteriorated. As more and more catalytic plants were blown in, more distillate oils disappeared, because in the catalytic plants the distillate oils can be used as part of the charging stock.

As we enter the 1944-45 heating season, we find that residual oils are beginning to ease. In some areas bunker C is beginning to come back to the market. Oil production in the U. S. reached an all time high in September at 5,000,000 barrels a day, it is believed. In a few cases PAW has permitted reconversion from coal back to the original fuel, oil. This is on a very limited scale, and in areas in which a slight surplus exists, but it is significant in marking a trend.

One persistent shortage, however, has not been eased. This is in the distillate oils. These oils will be tighter this winter than they have been heretofore.

To the fuel oil user, a cycle has been completed. He has seen a movement from heavy to light oils and back again to heavy oils.

Determining Best Temperature for Today's Heavier Oils

The return of the heavier grades of fuel oil to the consumer should be looked upon by him with favor because these oils are cheaper and yet have a higher heat content per gallon. With proper equipment, these oils are comparatively easy to handle and produce excellent results. With the need for fuel conservation, as stressed by the government, it is well to examine the adjustments of our oil burning equipment so that minimum maintenance and maximum efficiency may be obtained when using the heavier oils.

In considering the problem of burner adjustment, oil burners should be classified into two types: rotary and mechanical atomizing. The mechanical atomizing classification includes pressure atomizing burners and steam or air atomizing burners.

This division is made because rotary burners operate most efficiently when the oil at the rotating cup has a viscosity ranging from 200 to 300 seconds Saybolt Universal. Mechanical atomizing burners operate best when the viscosity of oil at the nozzle ranges from 100 to 200 seconds Saybolt Universal.

Since the viscosity of the oil is a function of temperature, we may make a viscosity chart by plotting the viscosities of various oils with respect to temperature. This chart (next page) illustrates six different oils varying in viscosity from 25 seconds to 500 seconds Saybolt Furol at 122 F. Viscosity is expressed in both the Universal and Furol units.

To determine the proper temperature of oil at the burner nozzle, it is necessary only to know the viscosity of the oil being used. This is obtainable from the fuel oil supplier and will be expressed in Saybolt Universal at 100 F or Saybolt Furol at 122 F.

For example, let us assume that we have a rotary cup burner to operate with oil whose viscosity has been given as 300 Saybolt Furol at 122 F. To find the best operating temperature at the cup, find 300 Saybolt Furol on the chart, follow horizontally to the intersection of the 122 F line. This is also the intersection point of the diagonal. Follow the diagonal to the horizontal line corresponding to 250 Saybolt Universal (mean between 200 and 300) and read down vertically. The corresponding temperature of the oil is found to be 202 F. It will be noted that for this oil to fall within the 200 to 300 Saybolt Universal operating range, the temperatures could vary from 193 F to 212 F; however, the mean is usually found to be the best operating point.

Other factors to be considered are the temperature in the fuel oil storage tank, the temperature at the pump, and the temperature in the heater. In considering the storage tank, it must be remembered that the oil is usually pumped by suction from the tank to the heater. It is, therefore, necessary to raise the temperature of the oil in the tank to a point at which the pump can handle it readily, and yet not to overheat it, so that under the vacuum created by the pump suction, no tendency to gasify will be exhibited.

The loss in heat from the tank to the oil heater should also be taken into account, particularly if the tank is buried outdoors at a considerable distance from the boiler room. To minimize heat losses from tank to oil pump, underground oil lines may be laid alongside of steam lines and wrapped together with hair felt and tar paper, or laid in split tile and insulated with rock wool.

Oil Viscosity for Pumpability

The maximum viscosity of practical pumpability of oil is 10,000 seconds Saybolt Universal, but easy pumpability occurs at 5000 seconds. To find the temperature of oil in the tank at which easy pumpability will occur, we again refer to the chart. Assuming again a 300 Saybolt Furol oil at 122 F, we follow

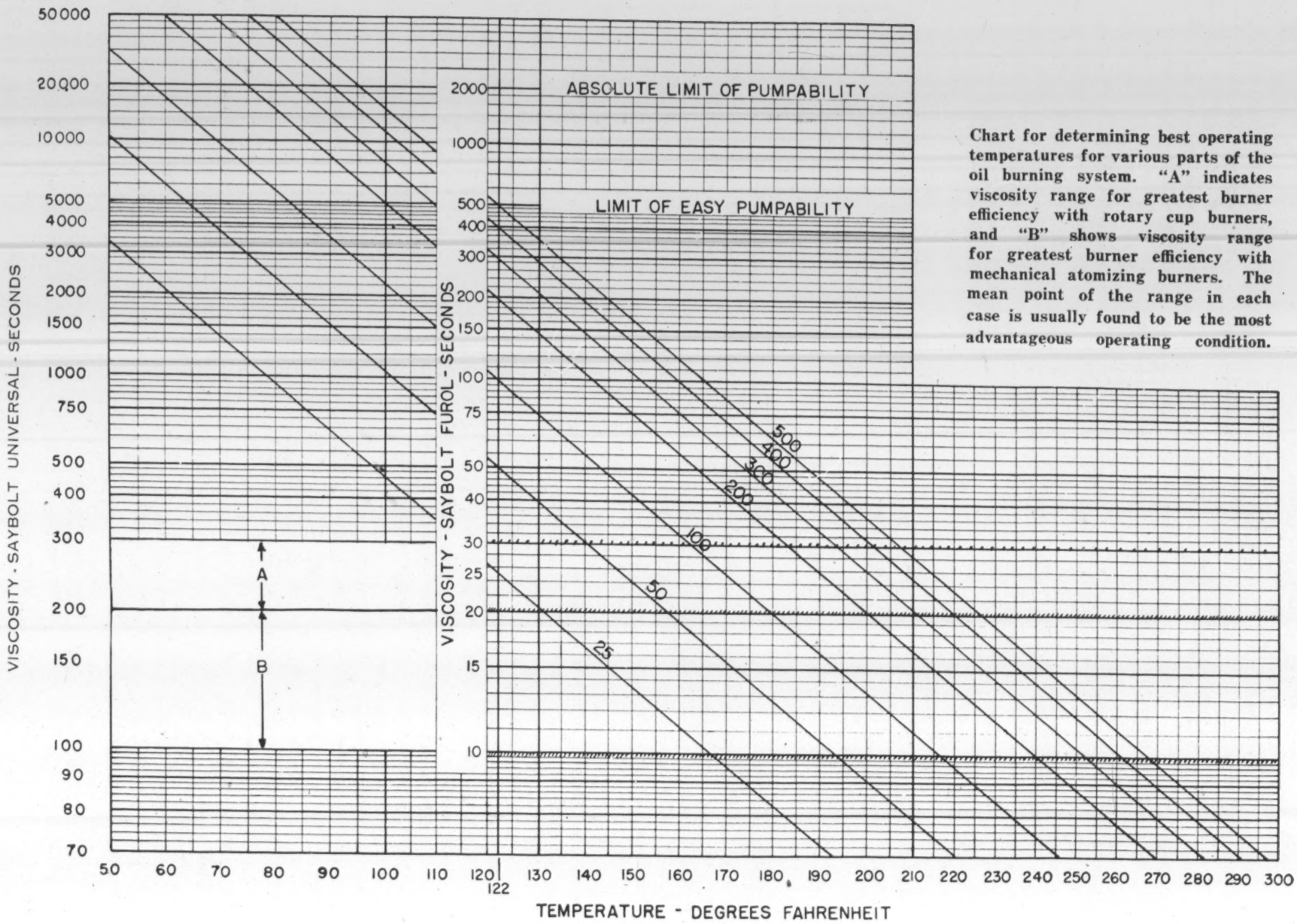


Chart for determining best operating temperatures for various parts of the oil burning system. "A" indicates viscosity range for greatest burner efficiency with rotary cup burners, and "B" shows viscosity range for greatest burner efficiency with mechanical atomizing burners. The mean point of the range in each case is usually found to be the most advantageous operating condition.

the diagonal line to the 5000 second Saybolt Universal line, and reading down we obtain 108 F temperature. It should be noted that if we follow the diagonal to the 10,000 second line (the maximum viscosity for pumping), the temperature would be 95 F. It is evident, therefore, that with extremely heavy oil, close temperature control at the tank will pay big dividends in maintaining good pumping conditions.

It is possible, with proper temperature control at the tank, to maintain a temperature within plus or minus 5 F of a predetermined setting. We now add the temperature drop between the tank and the inlet side of the oil preheater to our tank temperature and set the control to maintain the temperature. For example, suppose the temperature drop from the tank to the heater is 7 F; then the temperature at the tank should be set at 115 F.

We are now ready to adjust the temperature of the oil heater. To do this, it is necessary to set the heater temperature slightly above the burner cup temperature so that the drop in temperature between heater and burner may be offset.

In a similar manner the correct operating temperature for a pressure atomizing or steam or air atomizing burner may be obtained. In applying the chart to these burners it is necessary only to pick the proper viscosity range, namely, 100 to 200 Saybolt Universal. The tank and heater temperatures are selected in the same manner as described for the rotary cup burner.

It is apparent that there is a close capacity relationship between pump, heater, and burner. The pump and heater are generally sized to permit returning hot oil to the storage tank. Standby pumping, heating, and straining equipment should also be provided with heavy oils.

Many oil burning installations have been "evolved" rather than designed. A pump no longer needed in one department could be made to serve as a fuel oil pump. A heater once used, perhaps, for heating water became the oil preheater. The fact that they served, although mayhap not well, seemed to justify their use and other equipment was considered superfluous.

With the development of modern oil burners and controls has come the realization that oil burning equipment must be designed as a unit for proper and efficient functioning. The future undoubtedly points to the use of heavy and not light oils, so that well designed installations will be the rule rather than the exception.

[Photo of oil pumping, heating, and straining set, and photo of oil burning system, courtesy of Mid-West Heat Service. Oil viscosity chart courtesy of Todd Shipyards Corp., Combustion Equipment Div.]

REVIEWS POSTWAR RAILWAY CAR HEATING AND AIR CONDITIONING

EFFECT OF THE war on development work and postwar materials for railway equipment was discussed by E. D. Campbell, vice president of American Car and Foundry Co., at a joint meeting of two sections of the American Society of Mechanical Engineers early this year; his paper has been published in the September 1944 issue of Mechanical Engineering, ASME journal.

In reviewing the air conditioning and heating of railway passenger cars, Mr. Campbell said that "It is taken for granted that all de luxe travel equipment will be air conditioned. In thinking of air conditioning one is so apt to consider cooling only. Air conditioning engineers realize that conditioning the air means correct temperature for body comfort with proper relative humidity in the air under all conditions of outside weather. This idea of air conditioning has been completely developed and is in use in some cars. It is entirely automatic and will properly condition the air on the same trip in weather from zero to 100 F. This is the ideal system and will probably be generally adopted at some time in the future.

"It is fairly evident that the public is not completely educated as to the necessity of having fixed sash in air conditioned cars. This situation has been recognized by some railroads, and they provide for it by having one or two windows at each end of the car arranged to slide. The feeling regarding sash is due to breakdowns in the air conditioning equipment during exceptionally hot weather, under which conditions the passengers feel depressed. It is believed, however, that air conditioning equipment will be so designed and built that failures during trips will be practically eliminated.

"The demand for power for lighting, air conditioning, and other appliances has reached such proportions that a 20 kw generator is the minimum generally used. The accepted practice is to hang the generator on the underframe of the car and drive it through an attachment on one of the axles. Manifestly, this puts quite a load on the locomotive with trains having 16 to 18 cars. At the present time there is some agitation to have a self-contained power unit in each car. The source of power contemplated is a small diesel directly connected to the generator.

"It was mentioned that the future systems will incorporate heating as well as cooling. At the present time, however, practically all cars are heated by an independent system of steam heat controlled through the air conditioning switchboard. This system derives steam from the locomotive and is piped throughout the length of the train. Obviously a train length of 16 or 18 cars involves some problem of obtaining sufficient heat in the rear cars. This is largely overcome by stepping up the pressure and by regulation. Even so, 15 to 20 min is sometimes required after steam is turned on before the rear cars are sufficiently heated for comfort.

"The all weather system, predicted for the future, overcomes this difficulty by a different system of heat distribution. In the year 'round air conditioning system, the air is heated by being blown over heated fin tube coils."

Is a Changing Temperature During the Day More Comfortable Than a Constant One?

THE QUESTION OF THE MONTH

It may be that a somewhat changing temperature during the day in an air conditioned space is more conducive to the comfort of the occupants than is a temperature held constant at some point. What's your opinion or experience? . . . Charles S. Leopold and Cyril Tasker comment informally on the question, which was brought up recently by a reader of HPAC. . . . We'll welcome your remarks on this interesting matter, and if published we'll of course pay you for them. Let us know, too, what your nomination for the next "Question of the Month" is.

Is a changing temperature during the day in an air conditioned space more conducive to comfort for the occupants than a temperature held at some constant value? That's the question—and it's a controversial one—asked recently by a reader of Heating, Piping & Air Conditioning.

Here's what Charles S. Leopold, consulting engineer and a member of HPAC's board of consulting and contributing editors, has to say about it:

"I think the experimental work and experience is reasonably definite on this point; namely, that at 50 per cent relative humidity you only have a choice of temperatures between 75 and 80 F for normal occupancy with people in sedentary occupation. Temperatures centering on 76½ F are generally quite satisfactory, and most people become thoroughly adjusted to this temperature within 30 minutes. There appears to be very little chance of practical variation throughout the day.

"Shutting off the cooling cycle before the occupants leave is additionally objectionable, because if the refrigerating cycle is stopped and ventilation continued, the humidity rises rapidly; or, if the air system is shut down, ventilation is stopped. Both factors tend to increase the odor problem as many of the odors (tobacco smoke is one example) if not removed following occupancy tend for a time to increase before disappearance.

"I regard comfort as the passive end result of removing active elements causing discomfort and find that this concept leads me to less inconsistencies than the thought of directly producing comfort. If you accept this approach, the proper indoor atmosphere is one of which you are not conscious, which seems reasonable, and all active sensations are ruled out. To carry this thought a bit further: If you would carry indoors the outdoor variability of air velocity and direction, unsymmetrical radiation, and even the active sensation of freshness in contradistinction to the mere elimination of stuffiness, the end result would not be comfort—particularly for people in a sedentary occupation, as they would be actively aware of the atmospheric condition.

"Back in 1933 I published an article in Refrigerating Engineering in which I proposed the theoretical possibility of holding a constant effective temperature but varying dry bulb and relative humidity. This would be a very difficult procedure to apply in the field. Incidentally, in that paper I asked, 'Why do the comfort data fail?' and I wish now to state that the comfort data do not fail if you accept the higher winter effective temperatures which are mentioned in the ASHVE's Heating, Ventilating, Air Conditioning Guide, but are not as yet shown on the comfort chart.

"The reader who brings up this question may have in mind the reduction of the so-called entrance and exit shocks. In my judgment the entrance 'shock' is a very pleasant experience and the exit shock unpleasant. The mild exercise of walking away from the air conditioned space reduces the time required to be acclimatized to the higher temperature. Furthermore, the laboratory data indicate that if we are to maintain conditions between 75 and 80 F—namely, just below the sweat line—there is little appreciable difference in the entrance and exit shock whether the interior be carried at 75 or 80 F. A radical adjustment in perspiration is required in either case."

Cyril Tasker, director of research of the American Society of Heating and Ventilating Engineers, says that he does not recollect anything in our American technical literature on this point, but says that there are quite a number of references in some of the British publications. For instance, he continues, a recent paper by Dr. Thomas Bedford of the Medical Research Council in the British Journal of Industrial Medicine, vol. I, no. 1, January 1944, deals with this very point. Abstracting from this paper, the following is in general what he says: "During the war of 1914-18 the health of munition workers committee defined an invigorating atmosphere as being, among other things, diverse in its temperature in different parts and at different times rather than uniform and monotonous."

Bedford and his colleagues, in studying the effects of the environment on subjective impressions of freshness, from a statistical examination of observational data stated the requirements for a pleasant and invigorating atmosphere, Mr. Tasker points out. Among these requirements, they said, "The air

movement should be variable rather than uniform and monotonous, for the body is stimulated by ceaseless changing in the environment." They also state that feelings of warmth depend on the effect of the environment on the heat regulating mechanism of the body, while sensations of freshness or of stuffiness appear to be evoked by the stimulation or lack of stimulation of the skin by the environment. This stimulation is largely due to air movement, but the other thermal factors also exert their effects.

"It is seen that, to a large extent, they attribute feelings of comfort more to changing air velocities than to changing temperatures, but I think the one is very closely tied up with the other. I think we shall have to be careful in what we mean by changing temperatures because these changes are likely to be of rather small magnitude," Mr. Tasker states.

"Dr. Edy Velander, who is head of the fuel research institute of Stockholm, has told me of an experimental house or room in the institute in which they have arrangements for completely changing the air at regular intervals, and during this change the temperature drops several degrees," Mr. Tasker mentions. "Between changes there is only a very small and almost insignificant amount of ventilation; whilst the changes go on, the air movement is quite extensive. They find this, he said, quite stimulating.

"I think the whole question bears a more careful investigation than it has apparently had in this country so far," Mr. Tasker concludes.

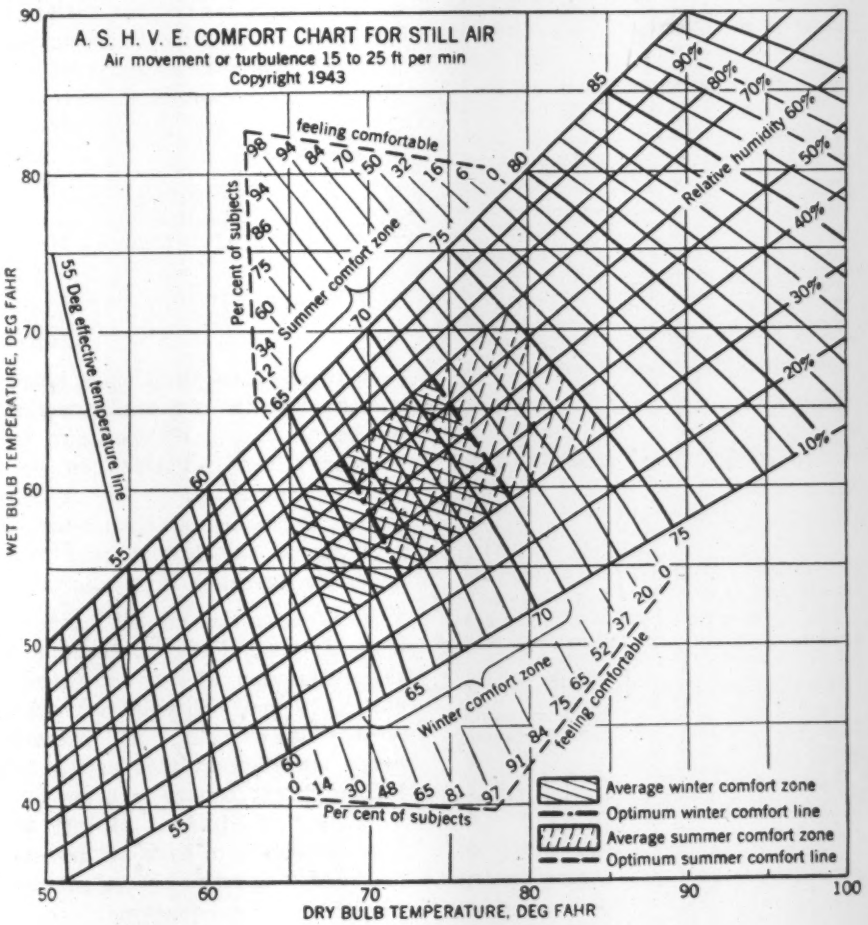
* * * * * *

What is your opinion on this question of a changing temperature during the day in an air conditioned space, as contrasted with constant temperature throughout the day? HPAC's readers will be interested in your views or experience, and the editors will welcome your comments. All discussions of the subject published in HPAC will be paid for at regular rates. Address The Editor, Heating, Piping & Air Conditioning, 6 N. Michigan Ave., Chicago 2, Ill.

THIS CHART SHOWS ZONES OF COMFORT

ASHVE comfort chart for still air. (Reproduced by permission of the American Society of Heating and Ventilating Engineers)

Note: Both summer and winter comfort zones apply to inhabitants of the United States only. Application of winter comfort line is further limited to rooms heated by central station systems of the convection type. The line does not apply to rooms heated by radiant methods. Application of summer comfort line is limited to homes, offices, and the like where the occupants become fully adapted to the artificial air conditions. The line does not apply to theaters, department stores, and the like where the exposure is less than three hours. The optimum summer comfort line shown pertains to Pittsburgh and to other cities in the northern portion of the United States and southern Canada, and at elevations not in excess of 1000 ft above sea level. An increase of one degree effective temperature should be made approximately per five degrees reduction in north latitude.


A. S. H. V. E. COMFORT CHART FOR STILL AIR
Air movement or turbulence 15 to 25 ft per min
Copyright 1943
feeling comfortable
Per cent of subjects
Summer comfort zone
Relative humidity
55 Deg effective temperature line
Winter comfort zone
Per cent of subjects
feeling comfortable
Average winter comfort zone
Optimum winter comfort line
Average summer comfort zone
Optimum summer comfort line
WET BULB TEMPERATURE, DEG FAHR
DRY BULB TEMPERATURE, DEG FAHR

ROOM COOLER NEED ESTIMATED

In a report on room coolers (less than 2 hp) submitted by the room cooler task committee to the refrigeration and air conditioning section of the War Production Board, it was estimated as of July 15, 1944, that the total number in use is 150,000, that the average "life" is five years, that 75,000 of the units are overage, and that 25,000 of the overage units are employed "essentially." In estimating the urgency of need (12 months when released), arranged in order of importance and indicating relative volume, the following figures are given: Replacements, 25,000. Necessary military needs, 2500. Immediate civilian requirements (industrial, hospitals, manufacturing processes, and professional), 2500. Desirable "transition" additions, 20,000. Additional needs when "normal supply" is available, 50,000. Total, 100,000 units.

The bill of materials given in the report for an average size ¾ hp unit includes 225 lb of carbon steel, 10 lb of alloy steel, 54 lb of copper and copper base alloy, 1 lb of tin, 22 board feet of lumber, 5 lb of paper, 50 sq ft of paper board, two fractional motors, one expansion valve, one relief valve, one seal, and one bellows.

SIMPLIFIED STEAM PIPE SIZING

Charles A. Pohlig, Assistant to the Superintendent of Steam Distribution, Union Electric Co. of Missouri,

Presents Tabulation of Factors to Take Some of the Work Out of Using the Unwin Pressure Drop Formula When Calculating Required Steam Pipe Size

STEAM PIPE sizing is accomplished in most cases by solving a desirable equation or consulting a graphical representation of an equation. After determining the maximum hourly flow, length of line, steam pressure, and quality that will prevail, our prime interest is pressure drop and pipe size.

After the equation or graph is chosen we must make a pipe size selection in order to determine the pressure drop. Upon completion of this routine we may find the pipe size selection inadequate, because the solved for pressure drop is either too high or too small. When this condition prevails there is but one alternative — choose another pipe size and repeat until the desired pressure drop is obtained.

The purpose of this article is to eliminate the "re-hashing" of pipe sizes when the desired pressure drop, hourly flow, steam pressure, and quality are known. The Unwin pressure drop formula was chosen for this purpose:

$$p_1 - p_2 = 0.000131\left(1 + \frac{3.6}{d}\right)\frac{W^2 L}{D d^5}$$

where p_1 = initial pressure, pounds per square inch, absolute; p_2 = final pressure, pounds per square inch, absolute; W = steam flow, pounds per minute; L = length of pipe, feet; D = average specific density of steam, pounds per cubic foot; and d = inside diameter of pipe, inches.

As an example, let us assume it is necessary to select a standard pipe size to pass 2105 lb per hr of steam at 100.3 psi gage pressure, steam quality dry saturated, through 100 ft of straight piping.

The method presented here allows the user to solve directly for pipe size rather than first assuming a trial pipe size in order to determine pressure drop. It is based on the Unwin pressure drop formula, is a re-arrangement of that formula.

The pressure drop in psi per 100 ft of straight piping in this particular case shall not exceed 0.50, and the pressure loss shall not be too much less than the prescribed amount for economical reasons. Using the Unwin formula, we proceed as follows:

If 2½ in. standard piping (inside diameter = 2.469 in.) is chosen, we would have:

$$p_1 - p_2 = 0.000131\left(1 + \frac{3.6}{2.469}\right) \times \frac{1230.8 \times 100}{0.25786 \times 91.328}$$

= 1.68 psi pressure drop per 100 ft of straight piping.

It is obvious that another pipe size choice is essential; let us choose 3 in. standard pipe (internal diameter = 3.068 in.) and proceed, using the same equation:

$$p_1 - p_2 = 0.000131\left(1 + \frac{3.6}{3.068}\right) \times \frac{1230.8 \times 100}{0.25786 \times 271.8}$$

= 0.50 psi pressure drop per 100 ft of straight piping.

In this case, 3 in. standard piping would be chosen because it complies with the predetermined factors.

This problem can be solved immediately by using the accompanying "steam pipe sizing tables." Consulting these tables:

Pressure drop = 0.50 psi per 100 ft of straight piping, corresponding "A" factor = 1.4142.

Gage pressure = 100.3 psi, dry saturated, quality, corresponding "B" factor = 0.38025.

Flow, lb per hr = 2105.

Then: "A" × "B" × Flow = standard pipe size factor, as per "S" factor, or

1.4142 × 0.38025 × 2105 = 1132, or 3 in. standard pipe size, as per "S" factor.

If superheated steam must be considered, the "C" factor in the steam pipe sizing tables accounts for 1 per cent differences to 164 F temperature; for intermediate temperatures it is possible to interpolate. "C" factors are approximate but are reasonably accurate between 0 and 200.3 psi gage pressure. The equation in these cases becomes:

"A" × "B" × "C" × Flow = pipe size factor "S."

The "S" factors allow for the selection of either "standard" or "extra strong" piping, the choice normally being governed by steam pressure, etc.

After solving for the "S" factor and for the corresponding pipe size it may be found that the tabular "S" factors are above and below the one calculated. In these instances it is possible to rearrange the equations for dry saturated or superheated steam, and solve for the "A" factor and the corresponding pressure drop:

$$\text{"A" factor} = \frac{\text{"S" Factor}}{\text{"B"} \times \text{Flow, Lb/Hr}}$$

$$\text{"A" factor} = \frac{\text{"S" Factor}}{\text{"B"} \times \text{"C"} \times \text{Flow, Lb/Hr}}$$

In these cases, the closest larger and smaller "S" factors appearing in the table may be used and the pressure drop calculated in both cases corresponding to the "A" factor. A decision may then be made relating to the proper pipe size, based on pressure drop allowance.

It is essential in all cases to make the usual allowances due to the resistance of valves, fittings, etc. This method does not eliminate that element. All pressure drops specified in this article are in pounds per square inch per hundred feet of straight piping, and it is necessary to have all pressure drops on this basis before proceeding with the calculations.

STEAM PIPE SIZING TABLES

Desired Press. Drop, Psi per 100 Ft Straight Piping	"A" Factor	Desired Press. Drop, Psi per 100 Ft Straight Piping	"A" Factor
0.01	10.0000	6.00	0.4083
0.02	7.0711	7.00	0.3780
0.03	5.7735	8.00	0.3536
0.04	5.0000	9.00	0.3333
0.05	4.4721	10.00	0.3162
0.06	4.0825	12.00	0.2887
0.07	3.7796	14.00	0.2673
0.08	3.5355	16.00	0.2500
0.09	3.3333	18.00	0.2357
0.10	3.1623	20.00	0.2236
0.20	2.2361	22.00	0.2132
0.30	1.8258	24.00	0.2041
0.40	1.5811	26.00	0.1961
0.50	1.4142	28.00	0.1890
0.60	1.2910	30.00	0.1826
0.70	1.1952	Super-heat,F	"C" Factor
0.80	1.1180		
0.90	1.0541		
1.00	1.0000	0=Dry Sat.	1.00
1.25	0.8944	12	1.01
1.50	0.8164	24	1.02
1.75	0.7559	37	1.03
2.00	0.7071	50	1.04
2.25	0.6644	63	1.05
2.50	0.6324	77	1.06
2.75	0.6030	91	1.07
3.00	0.5774	105	1.08
3.50	0.5345	119	1.09
4.00	0.5000	134	1.10
4.50	0.4714	149	1.11
5.00	0.4472	164	1.12

Gage Press. Psi	"B" Factor	"Y" Factor
0.0	1.00000	1.00000
0.3	0.99044	0.98097
1.3	0.96083	0.92319
2.3	0.93405	0.87245
3.3	0.90939	0.82699
4.3	0.88655	0.78598
5.3	0.86558	0.74923
6.3	0.84603	0.71577
7.3	0.82783	0.68531
8.3	0.81076	0.65733
9.3	0.79478	0.63167
10.3	0.77973	0.60798
15.3	0.71588	0.51248
20.3	0.66605	0.44362
25.3	0.61137	0.39139
30.3	0.59199	0.35045
35.3	0.56343	0.31745
40.3	0.53869	0.29019
50.3	0.49802	0.24802
60.3	0.46555	0.21674
70.3	0.43879	0.19254
80.3	0.41626	0.17327
90.3	0.39695	0.15757
100.3	0.38025	0.14459
110.3	0.36570	0.13374
120.3	0.35231	0.12412
130.3	0.34053	0.11596
140.3	0.32970	0.10870
150.3	0.32009	0.10246
160.3	0.31124	0.09687
170.3	0.30303	0.09183
180.3	0.29550	0.08732
190.3	0.28841	0.08318
200.3	0.28189	0.07946

Pipe Size, In.	Standard Pipe Dia., In.	Standard Piping "S" Factor	Standard Piping "V" Factor	Extra Strong Piping "S" Factor	Extra Strong Piping "V" Factor	Extra Strong Pipe Dia., In.	Pipe Size, In.
1/2	0.622	11.86	12705.0	8.09	16495.0	0.546	1/2
3/4	0.824	26.96	7247.0	19.84	8919.0	0.742	3/4
1	1.049	54.20	4470.0	41.57	5372.0	0.957	1
1-1/4	1.380	119.3	2583.0	95.67	3010.0	1.278	1-1/4
1-1/2	1.610	185.2	1897.0	151.3	2186.0	1.500	1-1/2
2	2.067	375.5	1151.0	313.6	1308.0	1.939	2
2-1/2	2.469	618.4	806.6	521.4	911.3	2.323	2-1/2
3	3.068	1132.0	522.4	968.1	584.7	2.900	3
3-1/2	3.548	1691.0	390.6	1460.0	434.9	3.364	3-1/2
4	4.026	2392.0	303.4	2080.0	335.9	3.826	4
4-1/2	4.506	3252.0	242.2	2845.0	267.2	4.290	4-1/2
5	5.047	4426.0	193.0	3891.0	212.3	4.813	5
6	6.065	7264.0	133.7	6326.0	148.2	5.761	6
7	7.023	10757.0	99.70	9205.0	112.0	6.625	7
8	8.071	15579.0	75.49	13395.0	84.58	7.625	8
9	8.941	20430.0	61.51	18576.0	66.10	8.625	9
10	10.192	28857.0	47.34	25678.0	51.73	9.750	10
11	11.000	35254.0	40.64	33211.0	42.55	10.750	11
12	12.090	45159.0	33.64	41915.0	35.62	11.750	12
14	13.250	57364.0	28.01	54586.0	29.10	13.000	14
15	14.250	69337.0	24.22	66212.0	25.09	14.000	15
16	15.250	82693.0	21.14	79215.0	19.21	15.000	16

How to use tables to find desirable Pipe Size or size corresponding to "S" factor - For dry saturated steam
Select desired pressure drop and corresponding "A" factor
Select desired steam gage pressure and corresponding "B" factor
Then: A x B x Flow, Lb per Hr = "S" factor and corresponding Pipe Size

If steam is "Superheated" the equation becomes: A x B x C x Flow, Lb per Hr

Steam Velocity, Fpm = Lb/Min. x "V" x "Y" (For dry sat. steam)
Steam Velocity, Fpm = Lb/Min. x "V" x "Y" x $(C)^2$ (For superheated Steam)

Note: "S" and "V" factors differ between Standard and Extra Strong Piping, the choice is usually governed by the steam pressure, etc.

Results of Competition Reveal

Design Trends in Apartment Heating

R. M. Balch, Jr., Summarizes Briefly Some Points of Interest on Control and Pipin

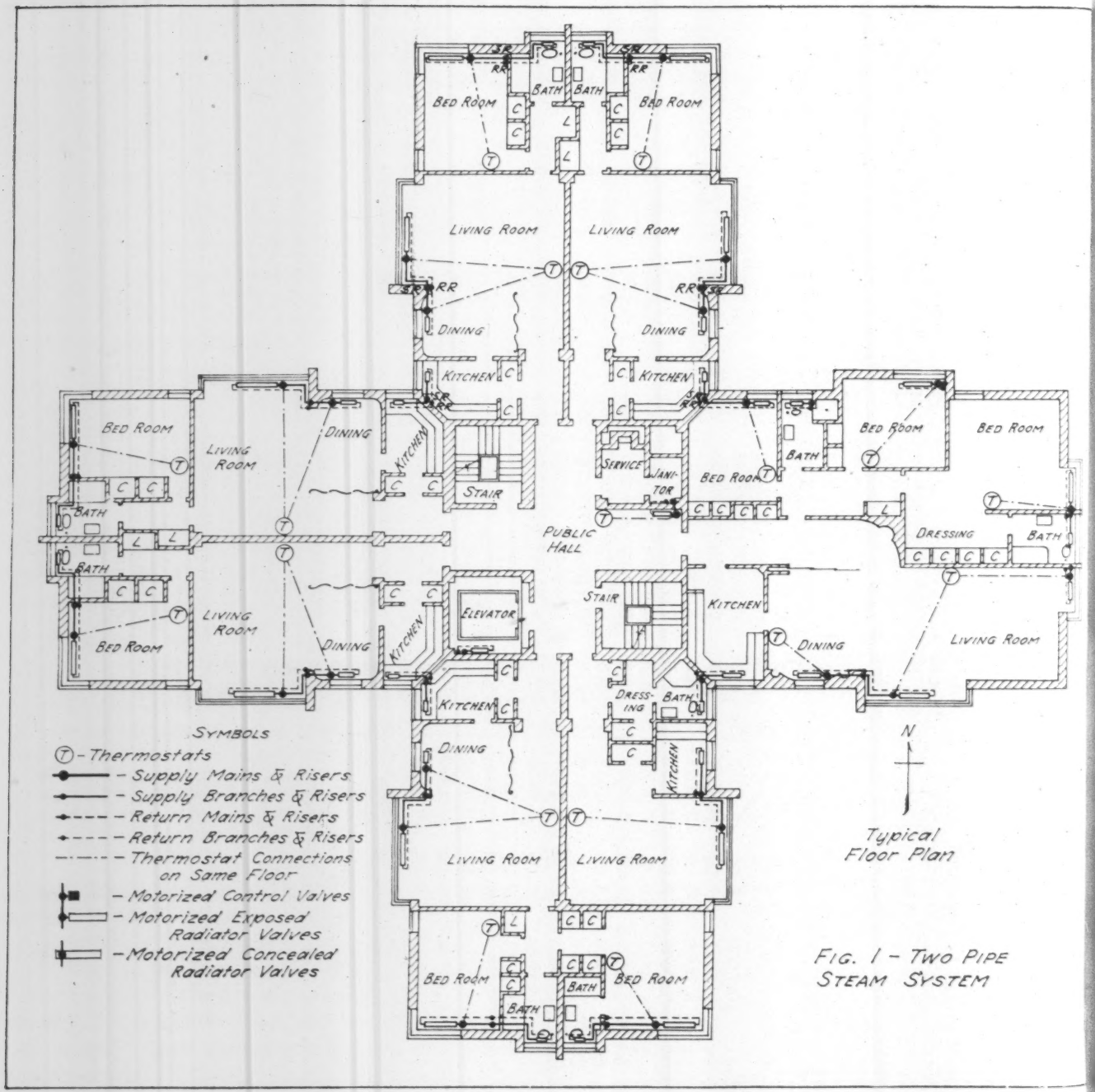


FIG. 1 - TWO PIPE STEAM SYSTEM

What are the trends in design and control of heating systems for apartment buildings? An analysis of the entries in a recent nationwide competition is one way to spot some of the trends, and such an analysis is given here by Mr. Balch (who is sales manager of the apartment controls division of the Minneapolis-Honeywell Regulator Co.) . . . He hits the high spots, telling the proportion of hot water to steam layouts, discussing briefly the two basic piping plans followed by the majority of the contestants, and describing two of the award winning entries — one of which is two pipe steam and the other of which is two pipe hot water

OVER TWO THOUSAND architects, engineers, and technical men from offices associated with the heating industry entered a recent contest on "personalized" apartment building heating system control. Submittals of piping layouts came from all sections of this country and Canada. Certain definite trends in apartment heating design were found by the judges in examining the layouts.

One trend indicated by the contest entries was found to be the use of hot water heating. One pipe and two pipe hot water was used by nearly two-thirds of the entrants. Of the layouts submitted in steam, over 90 per cent were two pipe. Here a very definite trend away from use of one pipe steam was shown. Radiant heating was offered by 45 entrants, these in hot water with the panel type of piping.

In the piping layouts, two basic plans were followed by the great majority. Approximately 65 per cent of the contestants showed vertical risers in outside walls, the majority concealed and insulated,

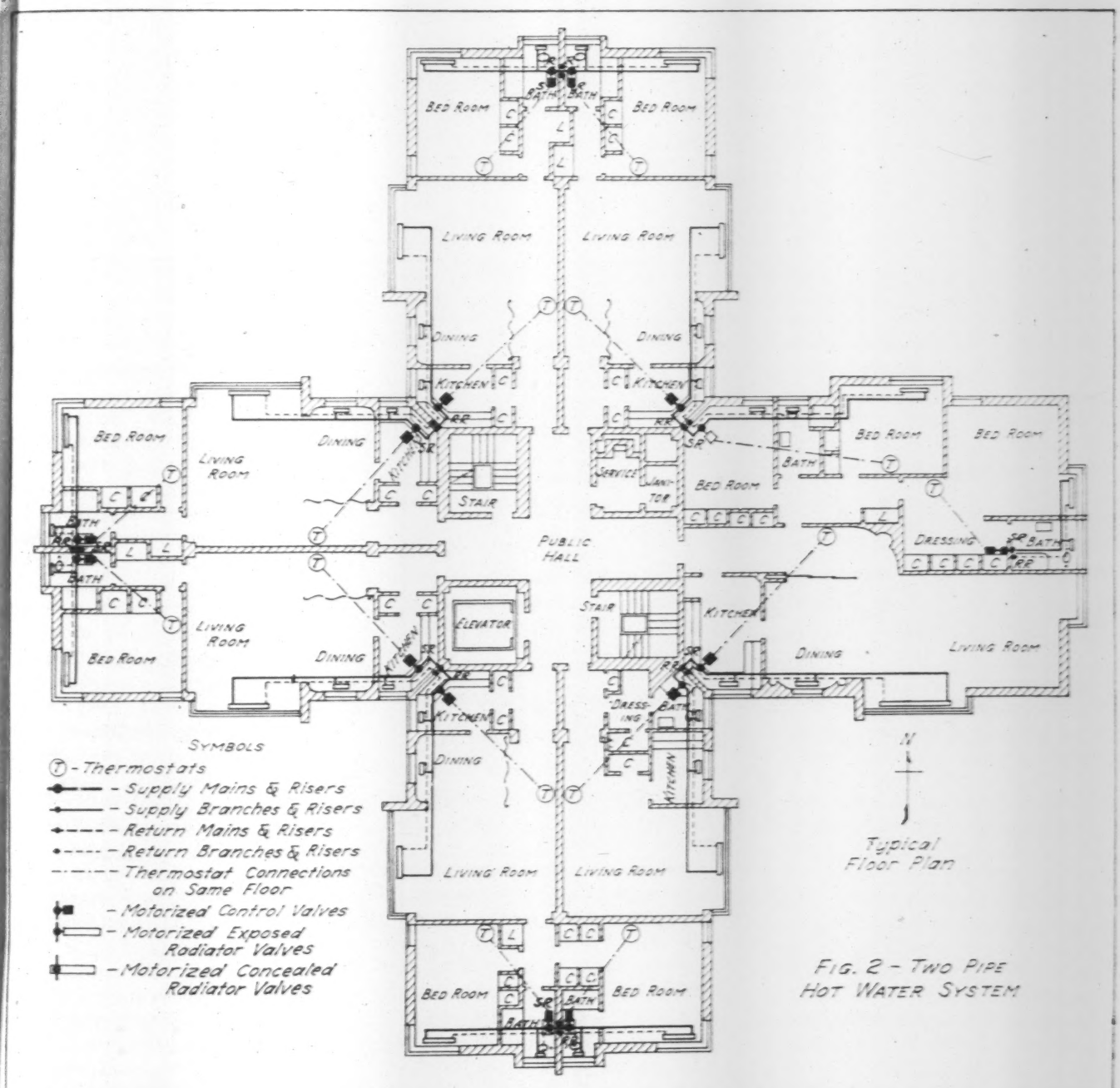


FIG. 2 - TWO PIPE HOT WATER SYSTEM

which fed two or four radiators on each floor. Both upfeed and downfeed systems were shown for both steam and hot water. The second group of contestants showed a basic design of grouping sets of risers in the center section of the building, with horizontal or lateral risers extending around each floor to supply all radiators in each separate apartment. Both one pipe and two pipe hot water were shown, in addition to steam, in this design.

Separating these two major types of piping design, it is obvious that the first, with risers in outside walls feeding fewer radiators on each floor, requires more valves for individual apartment control. The second plan of design, not used as much in past practice, of fewer supply risers located in the center section of the building with lateral runs feeding all radiation in each apartment, requires fewer motorized or zone valves. A problem in economy in enclosing these lateral piping runs was solved by many by use of a sheet metal cover at the baseboard of exterior walls, eliminating the necessity of coming through the floor slab and the use of a furred section of ceiling below.

The designs submitted showed individual room control, sectional control, and individual apartment control. Figs. 1 and 2 are two of the winning layouts, two pipe steam and two pipe hot water, respectively.

In Fig. 1, where the risers—22 supply and 22 return—are in the outside walls, short runs are made to radiators, so that individual radiator valves are used. In the one room apartment, one thermostat in the living room controls the radiator valve in the radiator in that room only. Kitchen and bathroom radiators are not automatically controlled. The one bedroom and two bedroom apartments have one thermostat on the inside wall of the living room, which controls individual radiator valves in the living and dining rooms. The kitchen and bathroom again are not automatically controlled. The three bedroom apartment has the same control design as in other bedroom apartments.

Automatic control at a reduced temperature may be provided for the entire building by means of an outdoor thermostat system or by means of clock type electric thermostats or day-night (electric or pneumatic) thermostats in the various rooms of each apartment.

In Fig. 2, where there are shown eight sets of risers, four sets in the interior section of the building and four sets near the outer portion of the four wings of the building, it will be noted lateral or horizontal runs are used from the vertical risers in the center section of the building. This plan of piping allows the use of zone valves which control three radiators each in the living and dining rooms of each apartment as well as two bedrooms and their bath of the three bedroom apartment. The bedroom and bath radiators in all apartments are controlled by a zone valve also, just off the vertical supply riser.

A compensated control with one bulb located in the hot water supply line to the radiation provides for hot water to the radiation at predetermined temperatures based upon outdoor temperatures, to provide for the greatest fuel economy. Automatic control at a reduced temperature may be provided for the entire building by means of an outdoor thermostat system or by means of clock type electric thermostats or day-night (electric or pneumatic) thermostats in the various rooms of each apartment.

These are only two of the 26 winning layouts. Considerable variation was shown as to placement of valves and thermostats. Also, a number of entirely new ideas were received, such as placement of radiation on inside walls with use of convectors which drew air from under windows through openings or ducts under floors. This idea, together with the use of plastic pipe and the use of extended surface steel tubing for radiation around exterior walls, was considered by the judges to be too new and unproved in design to be given contest awards.

BLUEPRINT FOR TOMORROW NOW!

In an effort to actuate those in a position to do so, to place designing orders now for construction to be built after the war, F. W. Dodge Corp. is promoting the use of the slogan, "Blueprint for Tomorrow's Needs Now!"

In announcing his company's backing of the campaign, Thomas S. Holden, president of the corporation, pointed out that the construction industry, because of its flexibility of organization and a vast deferred demand awaiting the release of critical materials, will probably be able to absorb manpower demobilized from the armed forces and war plants faster than any other line of business, commerce, or industry.

"Nearly everyone agrees," Mr. Holden said, "that the biggest job facing the country once victory is ours is to get service men and war workers back to productive work within the framework of our system of private enterprise.

"Less than half of the jobs planned for 'V Day' are in the design stage. The time to design the projects is now so that they will be ready for construction when the manpower and materials are ready for employment.

"By planning now, the period of transition from a war to peace economy will be shortened: the shorter the period of transition, the lower governmental costs, but more important—placing our demobilized service men in gainful employment will serve to bring about quickly their adjustment to a normal way of life."

The slogan and sticker design being used in the campaign were originated by E. O. Filby, a consulting engineer, for the use of the committee on water and sewage works development of four associations—New England Water Works Association, Federation of Sewage Works Associations, American Water Works Association, and Water and Sewage Works Manufacturers Association. The committee, however, grants permission for use of the slogan and stickers by others interested in promoting early construction revival with the proviso that no person or firm buy the sticker for resale at a profit, according to Mr. Holden.

"OPEN for DISCUSSION"

Steam Pressure Reducing Valves

Sabin Crocker, Jr., of Bethlehem Steel Co., Comments on the Dome-Loaded Reducing Valve

THE ARTICLES on steam pressure reducing valves by John J. Woolfenden published in the June and July issues of HPAC were of considerable interest. I note, however, that Mr. Woolfenden omitted any mention of the relatively new dome-loaded type of reducing valve, which probably will be widely used ashore after the war.

The dome-loaded type of pressure reducing valve was developed to overcome certain disadvantages of the weight-loaded and pilot-controlled types while retaining their advantages. A dome-loaded valve is simple and rugged in construction and is suitable for marine service. The few moving parts of a dome-loaded valve are simple shapes and of reasonably large size. Any mechanic can service one when necessary. Operation is not dependent on springs, packed glands, or pilot valves.

The basic moving parts of a dome-loaded reducing valve are the valve disc, push rod, diaphragm, and diaphragm support plate. The diaphragm is contained in a dome (pressure chamber) located, for steam service, under the valve body. This allows a water leg to form above the diaphragm, communicating with the reduced pressure side of the valve for protection against high temperatures. The valve opens against inlet line pressure. Any unbalanced force tending to hold the valve disc on its seat, together with the reduced pressure acting above the diaphragm, is opposed by a fixed air loading pressure acting below the diaphragm. As the reduced pressure increases, it acts in opposition to the loading pressure tending to shut the valve. As the reduced pressure decreases, the fixed loading pressure tends to open the valve. The air pressure carried in the dome of an unbalanced valve will be greater than the reduced pressure desired by an amount sufficient to overcome the unbalanced force on the disc and the weight of the valve parts and water leg above the diaphragm. It is preferable that valves on air or liquid service be installed with their domes above the line in order that any moisture within the dome be in contact with the diaphragm as a preservative agent. Diaphragms are of neoprene or rubber.

Charging the air dome may be accomplished in a variety of ways. Manually operated pumps may be used for pressures up to about 200 psi. An air service main, if available, may be used to charge the domes directly at pressures up to the main pressure or to operate an air booster pump for higher pressures.

The set pressure may be varied through a wide range without affecting regulation. Pressure regulation of a dome-loaded reducing valve is good. A 10 F change in air dome temperature will change the reduced pressure by about two per cent, but on steam service the effect is negligible. Valves can be arranged for large pressure reductions when on dead end service by the addition of a balance piston. The use of balanced or semibalanced construction reduces the effort required to move the valve and the pressure differential across the diaphragm, all of which tends to improve reliability and regulation. The air loaded side of the diaphragm is protected by a glycerine leg in one design. This construction tends to improve regulation under certain conditions by reason of the damping introduced, and acts as a preservative. Dome loaded valves are suitable for large pressure reductions in a single stage with regulation acceptable for many services. Some recent single stage installations handle 17,000 lb per hr of steam, 1400-400 psi; 3000 lb per hr of steam, 1230-250 psi; and 11,000 lb per hr of steam, 150-10 psi.

Large numbers of dome-loaded reducing valves are being successfully used by the Navy and Merchant Marine. Oil refineries and possibly a few other high priority industries have some in use.

Author's Reply by John J. Woolfenden, Smith, Hinchman & Grylls, Architects and Engineers

MY ARTICLE as published far exceeded the contemplated length and in view of the cutting and condensation that had to be done on the first draft of the original manuscript to reduce it to its final length, it seemed best to confine the discussion to the typical, familiar heating and industrial installation, and not to attempt to introduce variations which, in view of existing restrictions, might be considered as unusual or special for that class of work and, therefore, of academic rather than of practical interest to the average user, at least for the present.

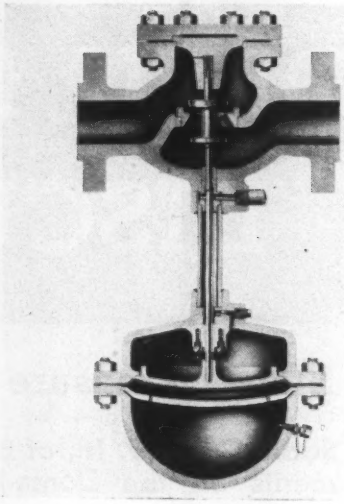
In regard to the various methods of charging the air dome mentioned in Mr. Crocker's above comments, it may be permissible to add that, when direct charging by permanent connection from an air supply main is used, should the air pressure in the main exceed that required in the dome, a suitable pres-

sure reducing valve is required in the supply connection to the dome.

It is obvious that, as Mr. Crocker points out, changes of temperature of the air in the dome will affect its pressure and consequently will affect the regulation of the valve. Although, as he states, the effect of relatively slight variations in the air temperature may produce negligible results when the valve is on steam service, the possible effect of the variations in air temperature should not be lost sight of since, especially in industrial installations, unless the valve is located with this in mind, it might be installed where it would be subject to such variations in temperature as would produce variations of pressure to an undesirable extent.

For example, there is quite a tendency today in some classes of work to locate certain portions of the equipment outdoors or in buildings which, save for the heat evolved by the operations conducted therein, are unheated.

Also, with the tendency towards large glass areas, there is always the possibility of sun effect. That this is by no means inconsiderable is shown by such occurrences as the melting of fusible plugs of automatic sprinkler heads due to the direct rays of the sun falling upon them through glass and by the overheating of electrical equipment due to the same cause.



Dome loaded reducing valve

Design and Control of Year 'Round Comfort Air Conditioning Systems . . . Reheating

Comment by S. F. Nicoll, Mechanical Engineer, York Corp.

I BELIEVE that Mr. Hendrickson's comments on Mr. Goodman's article, together with Mr. Goodman's reply to Mr. Hendrickson, published in "Open for Discussion" in the September HPAC, in general cover the subject quite clearly.

It appears to me, however, that such differences as they present center about the effectiveness of condenser reheat as against other methods of control, such as the bypass, and about the extent to which condenser reheat is likely to be applied.

With regard to the effectiveness of condenser reheat as compared with the bypass, it is of course apparent that the bypass cannot approach condenser reheat as a flexible and effective method of varying ratios of sensible to latent cooling. This, of course, is quite obvious to anyone acquainted with the problem of simultaneously cooling and dehumidifying air.

The example which I had used in my paper, and to which both Mr. Hendrickson and Mr. Goodman refer, clearly shows the relative effectiveness of condenser reheat as against other methods of control. Of course, it is obvious, and I believe I pointed it out in my paper, that as far as the example was concerned, the reheat could be from any source (steam, hot water, or refrigerant gas) as far as the fundamental discussion is concerned. I would like to point out, moreover, that the example which I chose was purely arbitrary and for illustrative purposes only.

I believe that Mr. Hendrickson and Mr. Goodman are evaluating the bypass from two different points of view. Mr. Goodman is perfectly correct in stating that the bypass is no match at all for reheat. This is reflected in the fact that reheat is most generally used on industrial applications where an accurate control of temperature and humidity is required.

On the other hand, the bypass, and even less effective methods of control, are widely used in comfort installations because they have generally been considered good enough under the circumstances and because more effective systems were not considered justified. For this reason I think Mr. Hendrickson is correct in his conclusion that the bypass has been widely accepted as being "probably close enough for comfort work." Mr. Hendrickson's conclusion, it appears to me, is based on what practice has been rather than on the mathematical analysis of the possibilities of the two systems. On the other hand, Mr. Goodman is correct in stating that the bypass is less effective than reheat for close control. Where widely varying ratios of sensible and latent cooling are required, the bypass is no equal for reheat.

With regard to the future use of reheat, it is quite possible that the extension of use of air conditioning in the postwar period, together with a more critical attitude of the results obtained on the part of prospective buyers, may result in a more widespread use of reheat or other arrangements to assure better control of humidity.

Author's reply by William Goodman, Consulting Engineer, The Trane Co., and Member of HPAC's Board of Consulting and Contributing Editors

THE DESIRABILITY of reheat is not a matter of "closeness" of control in comfort work; it is a matter of being able to limit the humidity to a comfortable maximum in installations in which the sensible load varies widely while the latent load remains approximately constant.

In evaluating any method of control in which the volume of air passing through the dehumidifier is varied under control of the room dry bulb temperature—as with the bypass—the type of application

must be considered. Control by varying air volume cannot be applied indiscriminately.

In theaters or restaurants, for example, both the sensible and latent loads vary, together with the size of the crowd. In other words, as the crowd decreases, the ratio line *rises* toward a horizontal position on the psychrometric chart. In such installations, control by varying the volume of air flowing through the dehumidifying coils is reasonably satisfactory for summer cooling alone.

On the other hand, in office buildings or hotels, the latent load is relatively small and approximately constant while the sensible load varies widely. As the sensible load decreases, the ratio line *drops* down toward the vertical on the psychrometric chart. In such installations, the use of control by reducing the volume of air flowing through the dehumidifier—of which the bypass is only one method—would hardly give satisfactory results in a year 'round air conditioning system.

Air Conditioning Multi-Room Buildings

Otto W. Armspach, Consulting Engineer, Says That Postwar Public Will Be Very Critical of Systems

I HAVE read W. L. McGrath's article entitled Multi-Room Buildings Pose Air Conditioning Problems of Their Own published in the August HPAC. There is a lot of "meat" in the article, and it is particularly valuable because it deals with a sound and basic principle of design. The application of this principle will contribute more than any other single feature of design to improving the room results produced by our postwar installations.

I am of the opinion that the future demand for air conditioned spaces will be tremendous but this demand will be made by a public who will be much more critical of the conditions to which they are subjected than has been the case in prewar years. The system which cannot simultaneously maintain conditions satisfactory to *all* individual tenants in an office building, for instance, will be considered a failure in design. Simple "zoning" will not be sufficient.

To comply with this requirement of individual temperature control will tax the ingenuity of the designer and will present a number of pitfalls which should be aggressively avoided. For example, the temptation to use volume control to maintain various space temperatures would, except in isolated cases, prove unsatisfactory. The installation, above everything, must be simple, direct, and positive in control operation.

Mr. McGrath in his article has shown, first, the need for "personalized" control; second, through an analysis of temperature and sunshine, the reason why requirements vary and, third, he has described a sound and simple equipment arrangement to meet these rigid requirements. A very constructive article!

MORE FUEL EFFICIENCY COORDINATORS NAMED

The national fuel efficiency program, conducted in cooperation with the U. S. Bureau of Mines, is a voluntary campaign aimed at the conservation of coal, oil, and gas in industrial and commercial buildings. In each local area, a coordinator—assisted by an advisory committee—arranges for the appointment of voluntary regional engineers who call on fuel users to explain the program, get a voluntary owner's pledge of cooperation signed, and suggest the naming of a "waste chaser" in each plant or building to see that fuel conservation opportunities are not neglected. Various check lists and quiz sheets which indicate how fuel may be saved in the operation of many types of equipment are available.

The names and addresses of the coordinators for many areas have been published in the July, August, and September issues of HPAC. Following are additional appointments during the last month. If you can take part in this campaign, or need information on eliminating fuel waste, get in touch with the coordinator for your area.

California

Sacramento Area—J. B. Hawley, Luppen & Hawley, Inc., Sacramento.

San Diego Area—R. J. Phillips, San Diego Gas & Electric Co., San Diego.

Georgia

Augusta Area—H. R. Creamer, Augusta Ice & Coal Co., Augusta.

Macon Area—Josiah Crudup, Professor of Physics, Mercer University, Macon.

Illinois

Harrisburg Area—Ralph D. Brown, Consulting Engineer, (Superintendent of Highways, Saline County), Harrisburg.

Maryland

Hagerstown Area—E. Gordon, Potomac Edison Co., Hagerstown.

Missouri

Hannibal Area—W. S. Watson, Board of Public Works, Water Department and Electric Light and Power Department, Hannibal.

New York

Syracuse Area—John B. Foley, Jr., John B. Foley, Jr., Co., Syracuse.

North Dakota

Fargo Area—J. F. McGuire, Northern States Power Co., Fargo.

Oregon

Pendleton Area—Albert Thews, Thews & Ryder, Pendleton.

Pennsylvania

Reading Area—A. S. Wertz, Wertz Engineering Co., Inc., Reading.

South Dakota

Sioux Falls Area—R. M. Crooks, Sioux Falls Gas Div., General Electric & Telephone Co., Sioux Falls.

Texas

Beaumont Area—Clem R. Winkler, United Gas Corp., Beaumont.

Vermont

Burlington Area—F. W. Kehoe, Superintendent of Buildings and Grounds, University of Vermont, Burlington.

PLANS FOR CONDITIONING FOR TRACKLESS TROLLEY

As soon as wartime shortages and restrictions make it possible, the Georgia Power Co. expects to have an experimental, air conditioned trackless trolley in operation in Atlanta, which—it is said—will be the first city in the U. S. to have an air conditioned trackless trolley, street car, or motor bus.

MIST AND DUST COLLECTION

Sampling of process and ventilation gases to determine performance of dust collection equipment, evaluate need for installing a system, or to obtain information for design . . . By C. E. Lapple

IN ORDER to determine the performance of an existing dust collection system, to evaluate the necessity of installing a collection system, or to obtain information for the design of a collection system, it is necessary or desirable to obtain a measure of the concentration and character of the dust in the gas stream. The securing of a representative dust sample, often a primary factor in the intelligent selection of dust collection equipment for a specific purpose, is usually a very difficult matter and subject to many errors. The most reliable type of sample is that taken by actual sampling of dust-laden gases, provided a correct technique is employed.

In sampling simple gas mixtures it is usually only necessary to exhaust a small volume of gas for analysis. In sampling dust-laden gases, however, special precautions must be taken to avoid segregation or classification of the dust from the gases. When taking a dust sample, it is essential that the sampling nozzle face directly into the gas stream and that the velocity of the gas in the mouth of the nozzle be the same as that in the main stream at the point where the nozzle is located. If the sampling rate is too low, so that the velocity in the mouth of the nozzle is less than that in the main stream, the dust particles in the main gas stream that is diverted around the nozzle will tend to enter the nozzle due to their greater inertia, this tendency being greater the larger the particle size. The sample obtained will not only contain a higher concentration of dust than the main stream but will contain a greater percentage of large particles. Similarly, if the sampling velocity is too high, the sampled stream will contain a lower concentration of dust than the main stream with a greater percentage of fine particles. For conditions generally encountered in practice, the sampling error due to such velocity unbalancing is practically nil for particles finer than 5 microns, whereas, for particles larger than 200 mesh, the ratio of concentration in the sampled stream to that in the main stream is substantially equal to the ratio of the velocity in the main stream to that in the sampling nozzle mouth. The quantitative aspects of sampling are discussed in further detail in References 2, 3, and 4.

Sampling Nozzle for Noncorrosive Gases

A sampling nozzle for use in noncorrosive gases at atmospheric temperature, which is easily constructed and has been successfully employed by the author, is shown in Fig. 1. This nozzle, when used in conjunction with the two-liquid "null point" differential manometer shown, will permit automatic velocity balancing. The nozzle is faced into the stream and the leads from the static holes in the outside tube and inside the nozzle mouth are connected to the two legs of the differential manometer. The gas flow through the sampling line is then adjusted until the interface in the manometer returns to its original zero point. This corresponds to a condition where the sampling velocity is equal to the main stream velocity. While this nozzle could be used as a pitot tube, it is usually preferable to meter the sampled stream independently with an orifice meter in the sampling line. The dust is collected by means of porous paper bags inserted in the line between the nozzle and the metering orifice. It has been found convenient to make these bags out of the porous paper used in domestic vacuum cleaners (e.g., Air-Way), folding and stapling the edges together.

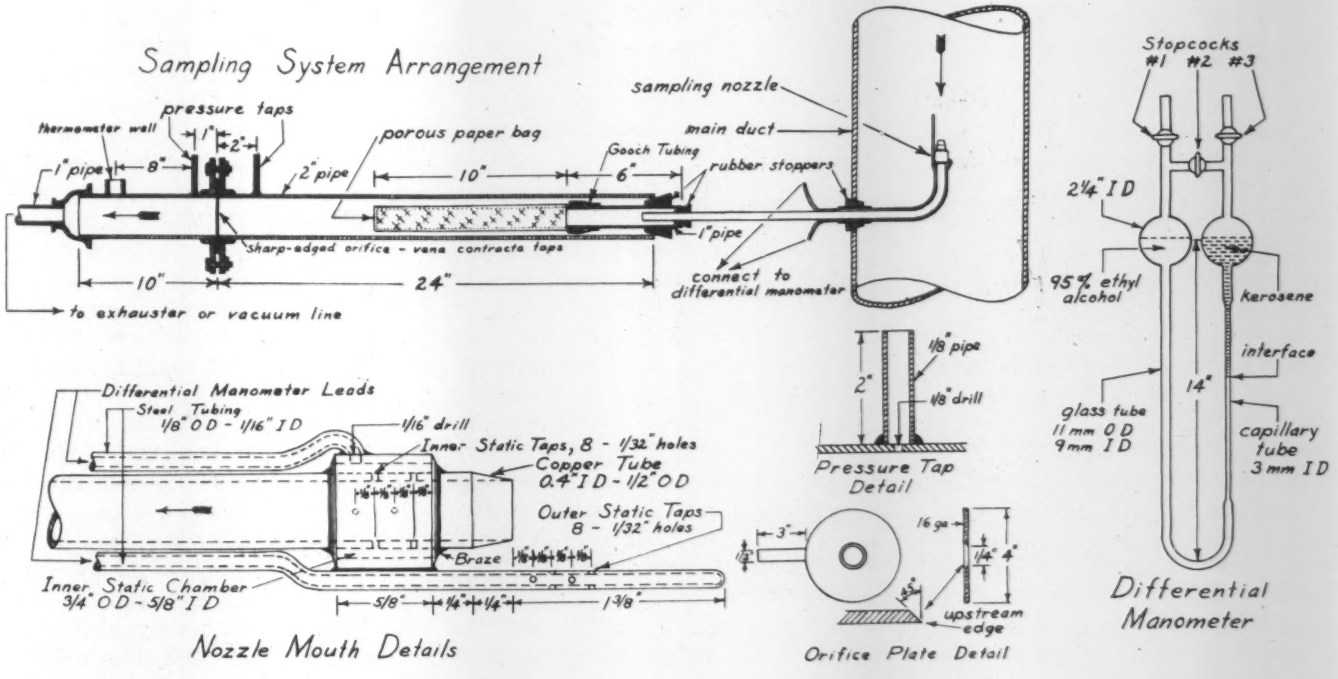
The successful operation of this type of sampler depends on the use of a very sensitive type of differential manometer. A simple water manometer, either vertical or inclined, is inadequate. The two-liquid type manometer, which de-

"Dust is all pervasive, everywhere, on land or sea . . . in all manufacturing processes; in the smoke from our furnaces." The problem of dust and mist control and collection is constantly receiving more attention and prominence, in order to eliminate nuisances, guard health and safety, reduce maintenance of equipment, recover valuable products, etc. . . . Mr. Lapple, of the technical division, engineering department, E. I. du Pont de Nemours & Co., reviewed the purpose of mist and dust control and collection, and discussed the characteristics of mists and dusts, in the July HPAC. In August, he considered the measurement and character of atmospheric pollution. In his third article this month, he writes on sampling process and ventilation gases.

pends for its operation on a small difference in density between two immiscible liquids as well as on the difference in diameter between the reservoir and the capillary tube containing the interface, has been found to be quite satisfactory. Kerosene and 95 per cent ethyl alcohol colored with methylene blue make excellent fluids for the manometer. Using these fluids, the manometer shown in Fig. 1 will have a deflection of about 1 in. for a pressure differential of 0.01 in. water, depending on the exact water content of the alcohol. Due to its high sensitivity, some practice is required in its manipulation to avoid "blowing out" the manometer. The lead from the outer static taps should preferably be connected to the interface or kerosene side of the manometer. The series of stop cock controls is suggested to avoid mixing of the liquids during insertion or withdrawal of the sampling nozzle in the duct and to facilitate the checking of zero points during sampling. All the cocks are kept closed during insertion of the sampling nozzle in the duct. The zero point is then obtained by opening cock 2. Cocks 1 and 3 are now opened and cock 2 is closed slowly, adjusting the gas flow at the same time to keep the liquid interface at the zero point. With cock 2 closed, the gas flow is then maintained to keep the interface at the zero point throughout the sampling period. The zero point should be checked frequently during sampling by opening cock 2 and then closing cocks 1 and 3. A two-liquid manometer is very sensitive to temperature changes and if the zero point changes during the run, the new zero point should be used for purposes of gas flow regulation. With this type of instrument, the total quantity of dust collected should represent the same fraction of the total dust in the main stream as the ratio of the nozzle mouth area to the main duct cross-section. However, since slight sampling velocity unbalancing or variations of dust concentration across the main duct cross-section will tend to cause serious errors if this method of calculation is used, it is generally better to meter the sampled stream and calculate the dust concentrations in the sampled stream directly.

For high temperature or corrosive gases, suitable modifications must be made in the construction. For such purposes a small cyclone separator followed by water scrubbers may be used to collect the dust. If dry samples are required, the sampled gases may be cooled and passed through a bag filter or a bag constructed of a fine screen (e.g., 400 mesh, type XXD Multibraid, Multi-Metal Wire Cloth Co.)

Fig. 1—Simple dust sampling equipment used by the author



may be used directly. Hardie (Reference 3) presents a resume of methods used in obtaining dust samples from gas streams, while Reference 1 discusses electrostatic means for collecting sampled dusts.

Location of Sampling Tube in the System

The location of the sampling tube in a system is equally as important as the actual sampling operation. Usually samples should be taken at various points across a duct to obtain a representative sample. The end of a long straight vertical section of duct is preferred as a sampling location. Long horizontal ducts tend to yield a heavier and coarser dust concentration near the bottom while a bend will tend to concentrate the dust at the outside walls. Due consideration must be given such factors before deciding upon a specific sampling location or type of traverse to be used and in interpreting results after samples have been obtained. It is sometimes desirable to install a mixing device (Reference 1), such as a nozzle or disk baffle, in the duct some distance upstream from the chosen sampling location.

Traverses are generally taken by dividing the entire duct cross-section into units of equal area. From five to 16 such units are used, the less uniform the velocity or dust distribution, the greater being the required number of points which should be sampled for accuracy. Rectangular ducts are divided into small rectangular or square units while circular ducts are divided into annular segments. Samples are then taken for equal time intervals at the center of area of each unit. Where the distribution is fairly good, the samples can all be collected at the same time by simply shifting the sampling nozzle. The average dust concentration of the gases is then calculated from the total weight of composite sample obtained and from the total quantity of gas sampled during the entire period. Where poor distribution is suspected, however, it is advisable to sample at each point separately so that a dust concentration distribution is obtained for consideration in a subsequent interpretation of the results. The throat of a contraction, nozzle or venturi, if such is present in the system, usually offers one of the best positions for sampling.

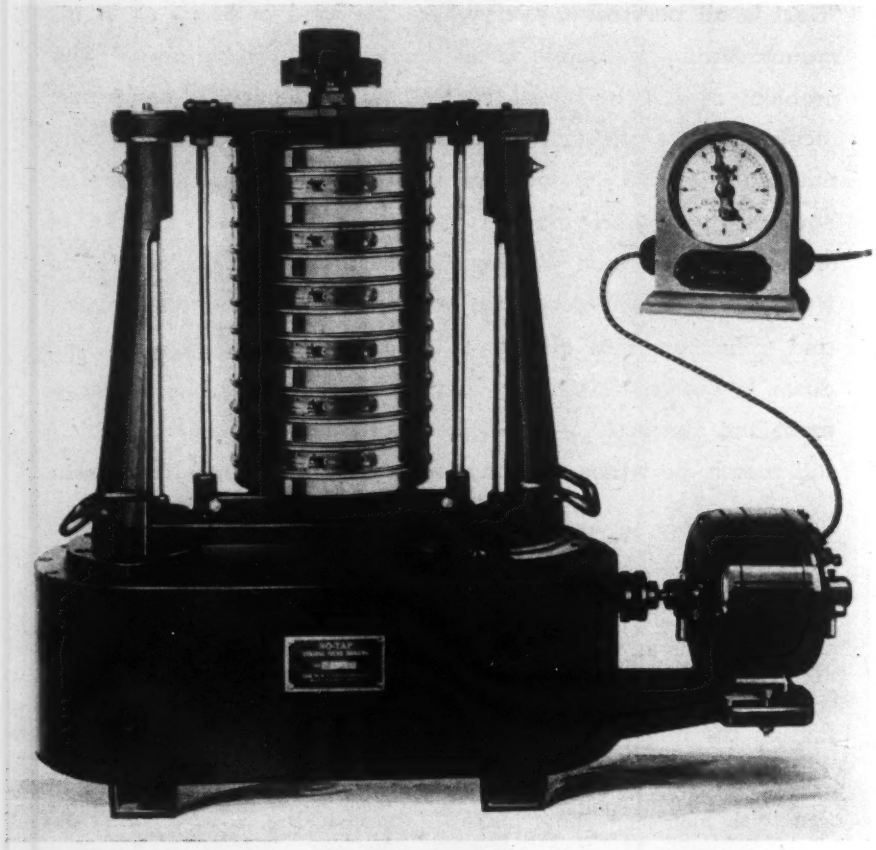


Fig. 2—A testing sieve shaker.

Having obtained a sample of dust, the dust concentration in the main stream can be calculated from the weight of dust collected and the total quantity of air passed through the sampling equipment. Proper weighting of results must, of course, be made where several samples are taken, depending on the type of traverse employed. Finally a representative composite of the dust sample can be used for purposes of particle size or chemical analysis.

Particle Size Measurement

Dust control is generally concerned only with the particle size range of 0.1 to 100 microns. This section is intended to give the reader a brief resumé of the available methods of particle size analysis in this range, with particular emphasis on those methods that are most suitable for use in dust control application. Heywood (Reference 6) and Schweyer and Work (Reference 9) have published particularly good, critical surveys of available methods of particle size analysis, which may be classified as sieving, microscopic, elutriation, sedimentation, and miscellaneous. Dalla Valle (Reference 5) and Roller (Reference 7 and also U. S. Bureau of Mines Tech. Paper No. 490, 1931) present a more limited resumé, while Work (Reference 10) concentrates on sieve and microscopic analyses. Schweyer (Reference 8) presents comparative data obtained by various methods of particle size analysis. For full details regarding any of the methods mentioned, the reader is referred to the above references or to any of the specific references given in the subsequent paragraphs and articles.

Sieving

Analytical sieves probably represent the best known and simplest method of particle size analysis. In such an analysis, a sample of dust, usually about 100 grams, is placed on a nest of sieves in which the coarsest sieve is on top and the finest sieve rests on a pan at the bottom. The nest of sieves is then shaken or vibrated, usually in a mechanical device such as that shown in Fig. 2, for a specified length of time. This time will vary

with the character of the material and is determined by sieving for a series of equal time intervals until the weight on any sieve does not vary more than one per cent between intervals. A simpler procedure, often used in practice, is to sieve until the incremental quantity collected on the pan during an interval does not exceed 10 per cent of the quantity collected on the pan during the first interval. While sieves can be used for particle size analysis down to 325 mesh (43 microns), it is often difficult to sieve some dry, fine materials accurately on sieves finer than 150 mesh due to their tendency to flocculate or "ball up" and to develop high electrostatic charges. For these cases, wet sieving has been found beneficial. For details on sieving procedure and data on the accuracy of sieve analyses, the reader is referred to References 10, 11, and 13. Weber and Moran (Reference 12) report data on the microscopic calibration of sieve apertures.

For sieve analyses, particle size is expressed in terms of sieve mesh or aperture. Thus a thin flaky particle, which would settle relatively slowly in air, may be assigned the same particle size as a much heavier regular particle which would settle very rapidly, while a rapid settling, needle-like particle might be assigned a much smaller particle size. Despite this limitation, however, a sieve analysis is valuable in dust control design to supplement sedimentation or elutriation analyses. For reasonably regular particles, a sieve analysis may in itself be sufficient provided too much material is not in the subsieve range. For operating control of grinding systems, sieve analysis has the outstanding advantages over other methods of ease and rapidity, though its limitations should be borne in mind.

[Photo of sieve shaker courtesy of W. S. Tyler Co.]

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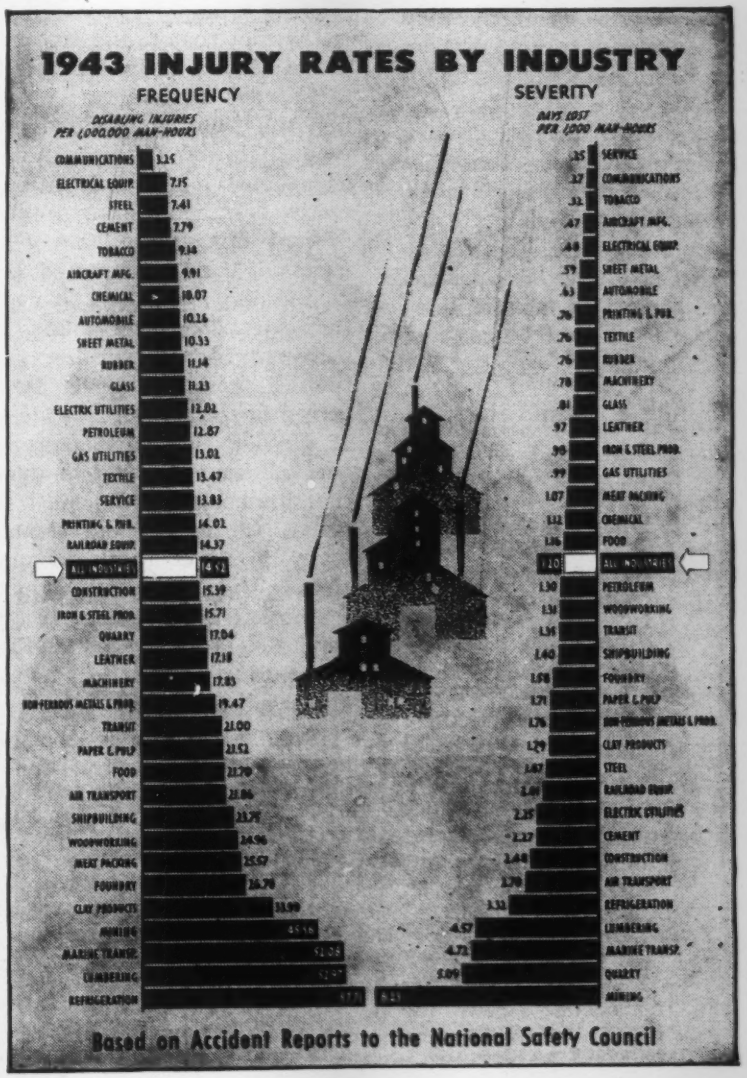

Design and Control of year 'round comfort Air Conditioning Systems

In one of the systems commonly used, temperatures in the various zones are controlled by automatically throttling the volume of air delivered to each zone. All of the disadvantages previously enumerated for control by means of air throttling—such as rising humidity during periods of light sensible load—apply with equal force to the zoned system in which the individual zones are controlled by throttling dampers. In addition, because some minimum amount of air must be provided for ventilating purposes, it is possible that on very light loads the room will be overcooled.

To avoid the possibilities of overcooling and of too high humidities during periods of light sensible load in a volume control system, independent reheating is frequently provided for each zone as an adjunct to the volume control. When the minimum air is supplied and reheating comes on, the dry bulb temperature in the room can be maintained but the humidity must rise—although not to as great an extent as if no reheating were provided. This is due to the fact that although the dew point temperature of the air is low enough, the weight of dehumidified air supplied to the room is insufficient to maintain the relative humidity at the design point if, as is often the case, the minimum supply of dehumidified air is set between 25 to 50 per cent of the maximum.

Definitely a Compromise

A volume control system with reheat is definitely a compromise between full reheating and no reheating at all. Because most air conditioning systems must operate at less than full sensible load a major part of the time, the operating costs may not be a great deal lower than in a system with full reheating and the results obtained are in no way comparable to those obtained with full reheating in which the air volume, and hence the moisture absorbing capacity of the air, is maintained at a constant value. In addition, control by volume even when reheating coils are added has the major disadvantage of requiring a change-over to reverse the thermostat action for winter and summer operation. Thus with volume control, the thermostat must close the air supply in summer on falling temperature. In winter the thermostat is required to open the damper on falling temperature.

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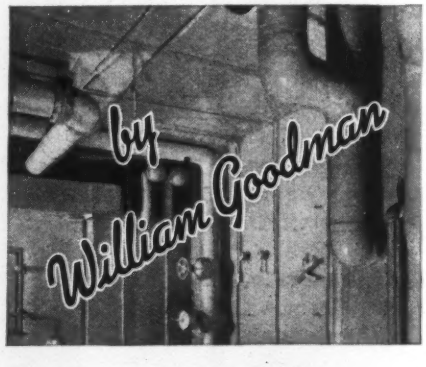
Air Distribution in the Room

Of course, the major disadvantage of the volume control system is the fact that the distribution of the air in the room itself is likely to be adversely affected by reducing the volume supplied to the room. However, this can largely be avoided today with either correctly designed ceiling outlets or by controlling the volume of air by means of dampers situated directly behind the grille and so designed that even though the volume of air delivered is reduced, the velocity issuing from the grille is maintained constant over a wide range of air delivery. As has previously been shown, any system in which the thermostat action must be reversed for winter and summer is likely to give unsatisfactory results in the spring and fall months.

Another zone system frequently employed is illustrated in Fig. 19. Separate recirculating fans only are used to circulate the air in each zone. All of the air is cooled and dehumidified at the central unit. No cooling coils are installed in the zone units. On the suction side of each zone fan, a set of mixing dampers is provided to proportion the amounts of return air and conditioned air in accordance with the demands of the zone thermostat. In this manner, as the temperature falls the volume of conditioned air is reduced and the volume of return air is increased. In other words, the temperature in the room is maintained by increasing or reducing the volume of conditioned air supplied even though the total air volume to the zone remains constant. The only advantage of this system over the one with straight volume control previously described is that the velocity of the air issuing from the grille and hence the distribution of supply air in the room is not affected by a reduction in the volume of chilled air. Otherwise this system has all of the disadvantages previously enumerated for control by means of straight volume reduction. On light loads the humidity will rise in the conditioned space, different zones cannot be heated and cooled simultaneously, the rooms are likely to be overchilled during periods of light load when the chilled air supply is closed down to the minimum required for ventilating purposes, and the thermostat action must be reversed for summer and winter operation. Sometimes, to prevent overchilling the spaces under conditions of light sensible load, and also to provide cooling and heating of different zones at the same time,



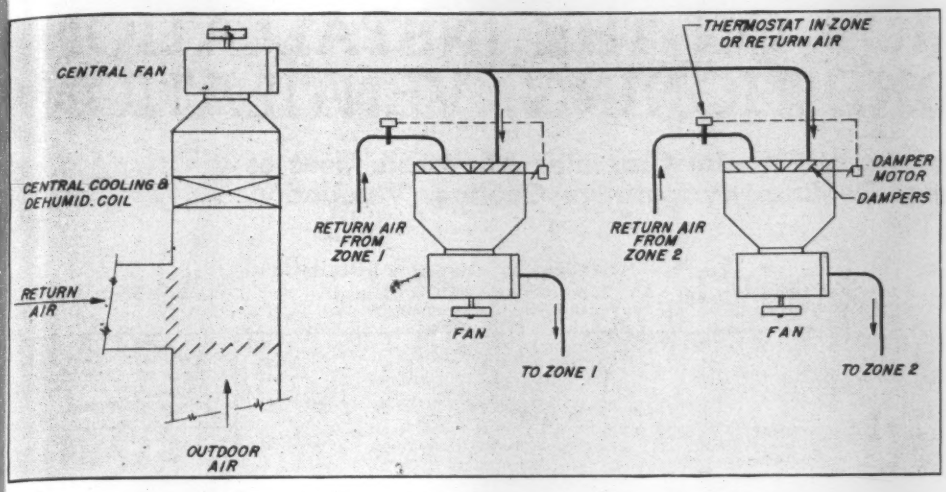


Fig. 19—Commonly used zone system with quantity of chilled air supplied to each zone varied in accordance with dry bulb temperature in zone. This is not a satisfactory year 'round system unless reheating coils are added in each of the zones.

reheating coils are frequently installed at each recirculating fan. The remarks previously made in regard to the use of reheating coils with volume control systems apply equally to the use of reheating coils with a double fan system.

Operating Saving May Not Justify Zone Fan Units

If reheating coils are installed in each of the zone fan units of Fig. 19 in order to limit the reduction in air volume, the saving in operating cost may not be enough to warrant the extra expense of the zone recirculating fan units. If the minimum central fan capacity is fixed at 20 per cent for ventilating purposes, the central fan must be capable of supplying air for this system at capacities varying from 20 to 100 per cent of full load. In addition, the local recirculating fans must also be capable of handling the full air volume required for the zone. Although the brake horsepower required by the two fans will not be much greater than the brake horsepower that would be required for only a central fan working against a greater pressure, the first cost is increased due to the duplication of fans, motors, and electric control equipment.

In a zone control system in which temperature is maintained altogether by reheating, no local recirculating fans are needed. A steam coil is simply placed in the duct supplying each zone, and the full volume of chilled air is supplied to the conditioned room at all times. This eliminates the need for reversing the action of the thermostat for summer and winter, and also eliminates the extra fan unit in each zone. Furthermore, with a straight reheating system there is the advantage that different zones can be heated or cooled at the same time and that the humidity is always positively limited to some maximum comfortable point.

Dual duct systems for delivering air to a number of different zones are also frequently used. In the dual duct system shown in Fig. 10 [see page 342, June issue] the air supplied to the warm duct is reheated after first having been chilled and dehumidified. However, in many dual duct systems the warm air is not dehumidified; it consists simply of air returned from the room and recirculated directly through the warm air duct again. In this case a dual duct system becomes simply another method of reducing the volume of air delivered to the conditioned space in accordance with the dry bulb temperature in the conditioned space. As the temperature in the conditioned space falls, more return air is bypassed around the dehumidifying coil and less air is chilled and dehumidified. A system of this type has the defect common to all systems in which control of temperature is by means of reduced volume—namely, that under conditions of light sensible load, the relative humidity may rise too high. Aside from this, however, the dual duct system in which the warm air is not dehumidified does have the advantages that different zones can be heated and cooled at the same time, and that no changeover is required to reverse the thermostat action from winter to summer. The need for reversing the thermostat action in winter in dual duct systems is avoided by placing the heating coils in the warm air duct.

In some dual duct systems provision is made for heating the return air when the sensible heat load decreases to such a point that the volume of chilled air supplied would have to be reduced below 50 per cent. After the room thermostat has moved the mixing damper to such a position that the air supply is composed of, say, 50 per cent chilled air and 50 per cent return air, any further decrease in sensible heat load is taken care of by reheating the return air. If the moisture load is still at the maximum, the humidity must obviously rise because of the reduction in dehumidified air. Though this system does have the merit of preventing the supply of dehumidified air from being cut to too low a point, it cannot under light sensible load limit the humidity to as low a point as a system in which the return air is first dehumidified and reheated.

Although zone control by varying the volume of dehumidified air is simple, it has inherent defects that must be recognized and offset in one manner or another if satisfactory results are to be obtained in a year 'round conditioning system.

VOLUME CONTROL

The basic principles that govern the design and control of year 'round conditioning systems are organized and discussed in the series of articles of which this is the eighth, and which is devoted to reviewing the advantages and disadvantages of commonly used zone systems with volume control.

ARMY POLICY ON THE INSTALLATION OF AIR CONDITIONING, VENTILATION

War Department Circular Classifies Allowable Uses of Mechanical Cooling, Evaporative Cooling, Ventilation

WAR DEPARTMENT policy for the installation of air conditioning, cooling, and ventilation in Army installations in the continental United States is set forth in a circular No. 148, recently issued. This circular, with the schedule and map, amplifies the policy set forth in the Army and Navy Munitions Board list of prohibited items for construction work for the installation of air conditioning or mechanical cooling, evaporative cooling, and mechanical ventilation. Section II, ASF Circular No. 143, 1943, should be consulted for allowable uses of "Freon-12."

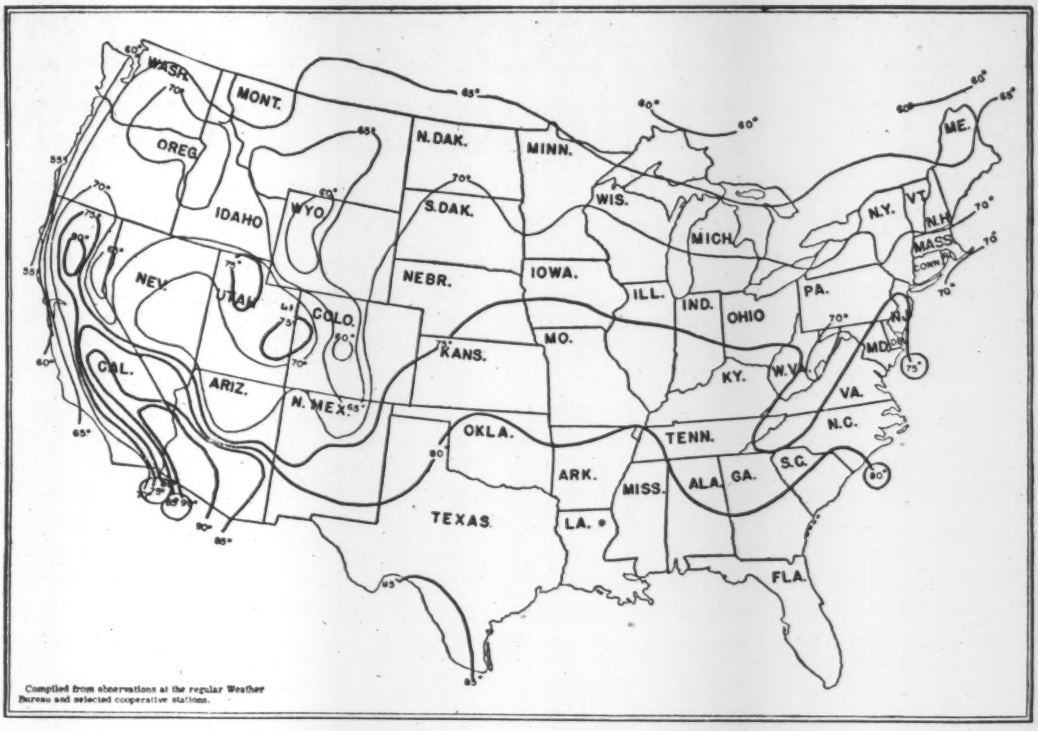
According to the circular, the installation of any of these systems will be confined to absolutely essential needs, and to the uses and thermogeographical regions indicated in the accompanying schedule. The boundaries of these regions are shown on the Weather Bureau map of normal July temperatures. In no case will physical comfort or the argument of increased efficiency of personnel be sufficient justification. All installations must be justified by local conditions of temperature, humidity, functional requirements, health of personnel, and proper utilization of space. In each case the system selected will be the simplest that will provide the required service. Air conditioning will not be installed where mechanical cooling or evaporative cooling will suffice. Artificial cooling will not be installed where mechanical ventilation will suffice. Mechanical ventilation will not be installed where gravity ventilation will suffice. Mechanical ventilation requiring centrifugal fans will not be installed where exhaust ventilation with propeller type fans will provide the required service. Evaporative coolers will be used only where climatic conditions make their use practicable. Duct work and equipment sizes will be kept to a minimum. Duct work will be nonmetallic wherever possible.

Schedule of allowable installations

Symbols: AC—Air Conditioning. EC—Evaporative Cooling. MV—Mechanical Ventilation. X—No mechanical installation of any type allowed.

Application	Regions as defined by isotherms on weather Bureau map of normal July temperatures			
	SW desert areas where temperature is 80° or more.	Areas where temperature is 80° or more (except SW desert area)	Between 80° and 75° Isotherms	Area where temperature is less than 75°
a. Product processing where essential for the control of temperature and/or humidity	AC	AC	AC	AC
b. Gun and armor plate plants to insure uniform charges for proof testing	AC	AC	AC	AC
c. Where required to insure accuracy of fine machine work and in manufacturing, inspecting, adjustment, repair, and storage of precision instruments and optical elements	AC	AC	AC	AC
d. Celestial navigation trainer and Link trainer spaces, jam handy and instrument trainer buildings, low pressure chambers and spaces housing synthetic training devices which by their nature require controlled atmospheric conditions	AC	AC	AC	AC
e. Main air traffic control towers	EC	AC	AC	AC
f. Flight control centers (any one of the 23 installations so defined by Army Air Forces)	EC	AC	AC	MV
g. Underground fortifications in plotting and switchboard rooms, mine casemates, command posts, and seacoast battery service magazines	AC	AC	AC	AC
h. Photographic laboratories and reproduction plants, limited to spaces required for processing and storage of materials, and for loading, unloading, and storage rooms for gun camera film, and for gun camera storage rooms	AC	AC	AC	AC
i. Evaluating or assessing rooms for reviewing gun camera films	EC	MV	X	X
j. Medical facilities:				
(1) *Hospitals.*				
(*a*) Surgeries	AC	AC	AC	X
(*b*) X-ray rooms and dark rooms	AC	AC	AC	MV
(*c*) Recovery rooms	AC	AC	AC	X
(*d*) Dental clinics (including dental laboratories)	EC	AC	MV*	X
(*e*) Clinics other than dental clinics (including infirmaries and receiving clinics)	EC	MV	MV*	X
(*f*) Flight surgeons clinics	EC	AC	AC**	MV
(*g*) Wards	EC	MV	MV*	X
(*h*) Patients' mess halls	EC	MV	MV*	X
(*i*) Patients' recreation rooms	EC	MV	MV*	X
(*j*) Sleeping quarters for personnel whose duties require regular or intermittent periods of night work to the extent of one officers' quarters building, one nurses' quarters building, and one barracks building, or 10 percent of hospital personnel, at each hospital, whichever is greater	EC	MV	MV*	X
(2) *Medical facilities other than hospitals.*				
(*a*) Flight surgeons clinics	EC	AC	AC**	MV
(*b*) Dental clinics (including dental laboratories)	EC	AC	MV*	X
(*c*) Central dental laboratories	EC	AC	MV*	X
(*d*) Service command laboratories and special laboratories	EC	AC	MV*	X
(*e*) Dispensaries and infirmaries where minor operations are performed	EC	MV	MV*	X
k. Sleeping quarters for nonhospital personnel whose duties require regular or intermittent periods of night work where the periods are 1 week or more in duration, and occur at least once a month	EC	X	X	X
l. Permanently blacked-out buildings without windows or provided with permanent closures which cannot be opened or removed for ventilating purposes	EC	MV	X	X
m. Special process spaces requiring a greater degree of ventilation than can be provided by gravity methods because of the nature of the materials or the production of dust, fumes, gases, or vapors injurious to the health of personnel	MV	MV	MV	MV
n. Dish washing spaces	MV	MV	MV	MV

*Evaporative coolers may be installed where humidity conditions make their use practicable.
**Evaporative coolers will be installed where humidity conditions make their use practicable.



Normal July temperature, degrees Fahrenheit

In areas outside of the regions specified, where it can be conclusively demonstrated that comparable climatic conditions prevail, consideration will be given to installations permitted for the similar thermogeographical region. In exceptional cases, where conditions make it absolutely impossible to provide sufficient cooling effect or ventilation to insure health and efficiency of personnel and proper utilization of the space by simpler means, consideration will be given to the use of evaporative coolers or mechanical ventilation for spaces other than those indicated. Cases presented for exception will include all pertinent information on which a decision as to necessity can be based, including the following:

1) Character, size, and use of space, and number of occupants.
2) Maximum outdoor temperatures and length of time such temperatures are encountered.
3) In the case of existing buildings which have been in operation, maximum temperatures prevailing in the working space, seasonal duration of these temperatures, and length of time personnel is exposed to them.
4) Brief description, with sketches, of desired installation, including number, location, size or capacity of proposed equipment, and extent of electrical and duct work involved.
5) Humidity conditions when applicable.

Existing inventories, both public and private, will be exhausted by the using services before orders for allowable equipment are placed which will directly result in new manufacture or fabrication. Procurement and distribution of new portable electric fans is prohibited. The distribution of existing depot stocks of portable electric fans is not affected by this circular.

The accompanying schedule shows maximum allowable installation of air conditioning, evaporative cooling, and mechanical ventilation. The type of equipment allowed for specific uses in the defined regions is designated by the symbols indicated, beginning with the highest category. Where equipment in the first two categories is permitted, equipment in a lesser category will be used if operable conditions can be thus attained.

CLASS A STOKER INSTALLATIONS UP

Factory sales of mechanical coal stokers for the first seven months of this year totaled 17,702 units of all sizes and types, compared with 18,581 units for the same period in 1943. Class A sales—stokers having a capacity between 61 and 1200 lb per hr of coal—totaled 16,800 units for the first seven months of 1944, compared with 13,806 units in the corresponding months of last year. Class B sales—residential size stokers—have been negligible in 1943 and 1944 due to the fact that the manufacture of these stokers was discontinued in September 1942 by order of the War Production Board.

Permits issued by the city of Chicago department of smoke inspection and abatement, covering commercial and industrial fuel burning installations for the month of August 1944 hit an all time high with a total of 293, of which 276 were for underfeed stoker installations. Permits were issued for six oil burning installations and one gas burning job. The few other permits covered a miscellaneous assortment of fuel burning equipment.

For the first eight months of this year, the smoke abatement department has issued permits for 1764 fuel-burning installations with 1640 covering underfeed stokers. Permits issued for all types of fuel burning installations totaled 905 for the same period in 1943.

These figures are based on reports issued each month by Frank A. Chambers, chief deputy smoke inspector. Permits cover only commercial and industrial fuel burning equipment. They are not required on residential and noncommercial small flat and apartment buildings.

ESTIMATING AND CONTROLLING HEATING FUEL REQUIREMENTS

ALASKAN CONDITIONS encourage special interest in estimating and controlling fuel requirements. With a design outside temperature in some places of —55 F, windows and storm doors and usage become increasingly important factors of variance from usual units of heat required per square foot of floor, cubic foot of volume, etc., customarily assumed for fuel estimates in the States. Diversified construction brings further complication to the problem, yet the need for reasonably accurate estimates of periodic fuel requirements and control of combustion efficiency is important because of limited storage facilities and the uncertainties of long-distance transportation.

Our one passenger train per week (except occasional weeks without any) illustrates the need for ample allowance between fuel shipments. Although some freight arrives nearly every day—some days—there remains an uncertain time interval between shipment and receipt. Available storage must therefore be intelligently employed to avoid disastrous lack of fuel during unpredictable periods of isolation. Current control of fuel economy is correspondingly important, both for conservation and practical operation.

We have relatively few central heating plants, and individual heating systems vary from power boiler size to combinations of room heaters. Hence our fuel requirements are peculiarly dependent upon individual building requirements. In a representative group, a moderate size building of typical construction was used as a basis of comparison. The individual heat requirements within the group were found to vary from 61.7 to 169 per cent of the heat required for the base building, per square foot of occupied floor space; 65.3 to 116.8 per cent per lineal foot of outside wall; and from 46.5 to 120.5 per cent per cubic foot of volume—and the variation appears not to be purely mathematical. Fundamental soundness of the familiar degree day method of fuel estimate and control, however, points to successful estimates if proper units are associated therewith.

It is therefore proposed to associate structure heat losses, calculated for selection of equipment, with the degree day gage of weather. Our outside temperatures show abrupt variation but it is hoped that computation of degree days on the basis of arithmetic average temperatures may be successfully continued. In the proposed method of reducing heat loads to the degree day basis, the design maximum net load per hour is multiplied by 24 and the product is divided by the design degrees temperature difference between the temperatures inside and outside the building. The resulting values are to be employed as Btu heat loads per degree day.

To make the calculations easy enough to assure systematic use, an alignment chart shown herewith has been prepared. It is believed that the directions and examples displayed thereon will help estimators to use it effectively after one short lesson. The chart is applicable to all fuels and purchased heat mediums and to all weathers. Improved accuracy of basic quantities more than offsets the slide rule approximations of chart readings.

The proposed procedure includes marking the building heat loads per degree day on site plans filed at each control center and requiring periodic reports of combustion efficiencies achieved. Ancient history doesn't help the individual operators very much, but if they know what happened with the next previous delivery of fuel they can more easily improve the efficiency of combustion in their units and reduce the stray losses and waste of heat. Systematic posting of results can be used to promote competitive improvement and the resultant savings per control center can amount to considerable conservation of fuel. Savings for groups of control centers can become really important to group management.

Brief observation indicates relatively marked economy with well arranged heating systems as compared with more rough-and-ready types. Data thereon are not complete and perhaps not conclusive, but shops heated by systems having skillfully placed return air take-outs seem to use less fuel than otherwise similar systems involving mass movement of returned air across occupied floor area. The latter jobs seem to require slightly higher ambient temperature to achieve equal general comfort. Hence the competitive credits awarded for combustion efficiency will probably be based largely upon improvement as well as sustained efficiency.

In this pioneer region, weather reports in the form of degree days are just becoming available. "Oldest inhabitant" advices are too erratic for bases of fuel estimates and there seems to be little accurate data at hand beyond a few years' records at a limited number of weather stations. There is hope, however, that a rational start will expedite achievement of important fuel conservation through systematic control of combustion efficiency and reduction of waste heat.

Low outside temperatures, limited storage facilities, and the uncertainties of long-distance transportation in Alaska make it more important than ever that fuel requirements be carefully estimated and fuel usage be conscientiously controlled, says R. A. Small. The problem has been put on the degree day basis, and an alignment chart constructed to simplify systematic calculations of combustion efficiency and the required fuel supply, as explained here.

ESTIMATE CHART

FUEL SUPPLY — COMBUSTION EFFICIENCY

Z Btu per degree day × **Y** degree days = **X** Total Heat = **Z** Btu per unit of fuel × **Y** net units converted to heat

Y Net units ÷ **W** combustion efficiency = **X** fuel supply as burned

Multiplication Digits

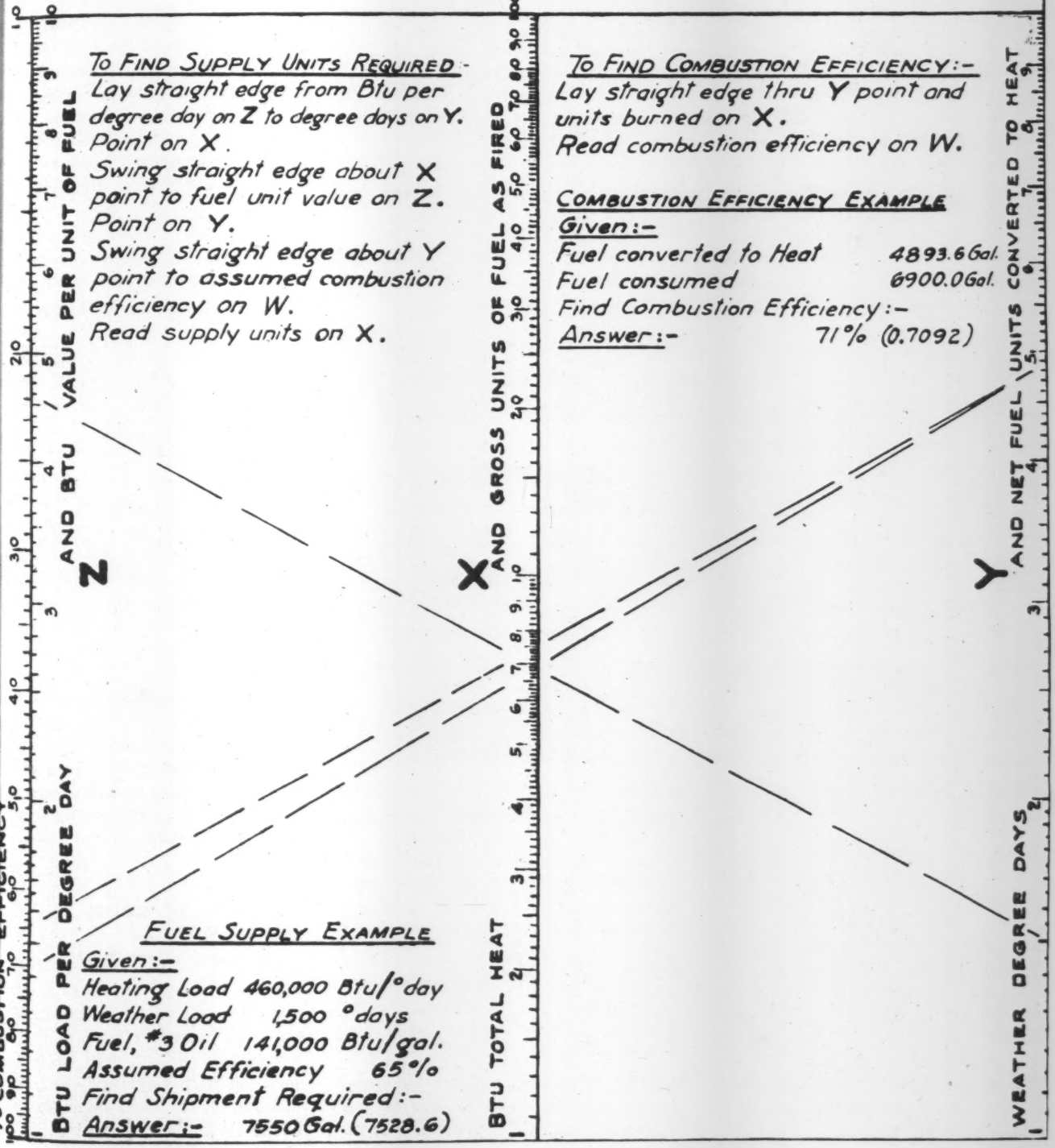
Prod. on X at 10 or above = Z + Y

Prod. on X below 10 = (Z + Y) − 1

Division Digits

Quot. on X at 10 or above = (Y − W) + 1 (Dividend on Y Axis)

Quot. on X below 10 = Y − W



To Find Supply Units Required:-

Lay straight edge from Btu per degree day on Z to degree days on Y.
Point on X.
Swing straight edge about X point to fuel unit value on Z.
Point on Y.
Swing straight edge about Y point to assumed combustion efficiency on W.
Read supply units on X.

To Find Combustion Efficiency:-

Lay straight edge thru Y point and units burned on X.
Read combustion efficiency on W.

Combustion Efficiency Example

Given:-

Fuel converted to Heat	4893.6 Gal.
Fuel consumed	6900.0 Gal.

Find Combustion Efficiency:-

Answer:- 71% (0.7092)

Fuel Supply Example

Given:-

Heating Load	460,000 Btu/° day
Weather Load	1,500 ° days
Fuel, #3 Oil	141,000 Btu/gal.
Assumed Efficiency	65%

Find Shipment Required:-

Answer:- 7550 Gal. (7528.6)

SAM LEWIS' PAGE

In this regular feature, informal comment on heating, piping, and air conditioning problems and their solutions is given — at the request of the editors — by Samuel R. Lewis, consulting engineer, and a member of HPAC's board of consulting and contributing editors

Underground Service Piping

THERE IS NO "department" in heat transmission more abused than that of underground service piping. Waste of fuel, the necessity for frequent repairs, and inexcusable leakage of condensate following incompetent design of underground piping systems are situations frequently encountered.

A basic premise is that the conduits shall be dry. They will not be dry unless they are watertight. If they are not kept dry, the insulation on the piping deteriorates and falls off and the melted snow above the conduits advertises the incompetency of the designer.

The insulation on the piping should protect *all* of the piping. This means avoidance of bare spots on pipe bottoms where rollers permit expansion movement. The insulation on the pipes should be moisture resistant. If by any accident the conventional prefabricated sectional pipe covering becomes wet, it sags away from the pipe and loses its effectiveness. This then is an argument for a moisture sealed insulation on the pipe within the conduit, with metal bearing plates outside of the insulation to transmit the weight of the pipe and its contents to the supports. If concrete is employed in making the conduit, wood forms for the interior left in place should be viewed with alarm, since the wood absorbs and retains moisture, may swell and crack the concrete, and thus will invite entry of more moisture.

The concrete mix should be as dense as possible, and metal reinforcing should by no means be omitted. Construction joints will be unavoidable, and can be depended upon to leak. There must be an exterior drain tile definitely leading to assuredly effective outlets.

It is important, therefore, that the top and sides of the conduit shall be watertight, shedding the water to reach a subdrain, both

drain and conduit being surrounded by a porous filter. Washed pebbles are to be preferred to crushed limestone for this filter, since they are usually less likely to contribute to clogging the drain.

To waterproof the top and sides of the conduit, a reasonable material appears to be standard composition roofing applied with hot pitch.

The gravel filter below the base of the conduit and surrounding the drain tile must be protected from being sealed by cement or concrete leaking into it when the conduit base is being poured. This might be done by laying the base upon a tarpaper pad above the filter.

Ventilation of the interior of the conduit around the insulation from manhole to manhole, will aid greatly in maintaining the essential dryness.

The conduit should be large enough in cross section to give several inches clearance between its interior surfaces and the outside of the pipe insulation.

These recommendations may suggest something of the pains that should be taken in building any conduit system. They may suggest that, after all, there will generally be no appreciable saving by building a home-made conduit over employment of one or the other of the factory fabricated conduits now available.

A concrete conduit recently replaced after 15 years' service was found in the following condition:

The interior wood forms were wet and spongy.

There were many cracks in the concrete top of the conduit, capable of admitting streams of water.

The drain, imbedded in a crushed rock fill, was partly clogged by solidified cement grout which had run through the crushed rock filter when the base was poured.

The side walls of the conduit had cracked loose from the base, presumably because the masonry of the sides and top was heated, while the tile or concrete base was relatively cool.

The pipes were very badly rusted where the insulation had been omitted at the rollers. The rollers and their supports were rusted almost completely away, a condition that possibly might have been avoided had ventilation been provided.

FREDERICK W. SMITH LEAVES WPB

Frederick W. Smith, for 1[illegible] months chief of the special equipment branch of the general industrial equipment division of the War Production Board, will become associated with Carrier Corp. on November 1, it was announced by Cloud Wampler, president of the air conditioning and refrigeration company.

Success — or the Failure — of an Installation Depend Upon Its Operation and Maintenance

It Is on the Operating Floor Where the Best Is Gotten Out of Any Item of Mechanical Equipment or Device, Says Lester S. Ries, the Superintendent of Buildings & Grounds at Oberlin College

WHILE LISTENING recently to a learned panel discussion at an important meeting of a national group of engineers, a striking remark was made by a man responsible for the operation of more than 800 heating plants, in response to a request made for criticism of the discussion. Opening his remarks, he said, "I must condense this interesting discussion to the items that I can take home to the men on the operating floor, because it is there that savings and economies, if any, are made."

In the course of all researches made by engineering groups, there comes a time when the application of this intensive effort must eventually be brought home to the operating and maintenance man. Many cases could be cited where expensive apparatus has been installed, representing the expenditure of thousands of dollars, which, because of ignorance on the part of the owner and the lack of interest on the part of the installer and manufacturer, has never been effectively used. For example:

In the construction of a museum in one of our institutions of higher learning, a complete installation of temperature control instruments and devices was made. The staff employed to maintain livable conditions in the exhibit spaces was never advised of this installation by the architect, the contractor, or the owner. After a lapse of more than 15 years the author was called upon to inspect the building and made inquiry as to why the temperature control devices were not being used. It was found that no one on the staff was conscious of the availability of this installation. Steps were then taken immediately to overhaul the system and the entire installation was revitalized and made to function.

In another case a monumental type of building, with a complete system of refrigeration installed for summer cooling, used it but several times. Then a change in personnel was made in the engineers' staff. The new operators decided this cooling equipment was unnecessary in the operation of the building. This refrigeration system, to the author's knowledge, has not been used for the past 10 years. Neither the owner nor the manufacturer of the equipment has seen fit to educate the maintenance and operating staff to integrate this important equipment into the functioning of the building.

In items as simple as the average apartment house stoker many operators fail to make adjustments necessary for the most efficient operation—adjustments required for change in fuel feed and air supply —because they are unfamiliar with the refinements on the machines and the need for modifying the operation to fit changed conditions.

Instruction Needed

These are not isolated cases. They represent all too frequent situations of laxness in making the most of available devices and equipment by neglecting to inform the staff in charge of the operational techniques, of the flexibility of the equipment which it has to operate. Posting diagrams with finely printed directions does not seem altogether to meet this need. Whether these instructions are lost, or mutilated beyond legibility, or just not consulted, is difficult to say. In most cases the maintenance man is instructed regarding equipment under his care when newly installed. Subsequent operators may not wish to be considered less skillful than the men they are replacing and often neglect to inquire regarding the full scope of these installations at the time of their employment. In some cases this attitude results in partial or complete disuse of fine equipment for long periods of time. It is even possible that an owner, unfamiliar with the capabilities of the devices he has purchased years before, may actually buy new devices to perform functions identical to those expected of the equipment originally installed, in the hope of reducing costs to a figure that will make a profitable investment return or provide added comfort to tenants.

As a group, engineers primarily concerned with design or supervision are prone to credit the maintenance and operating staff with the analytical attitude they themselves possess. It must be borne in mind that many individuals enjoy their work when it is routine and does not require flexibility. Repeating tasks has a charm that may work to disadvantage and result in a failure to get complete service from the apparatus. The opposite is sometimes encountered where the operator, by means of clever hookups and gadgets, gets more out of the equipment than the engineer or manufacturer designed originally in its construction. But an operator of this type does not generally stay long in this kind of work, probably finding employment where his talents can be used to even better advantage. Provision for educating the operator so that he becomes entirely familiar with the equipment and installation for which he is responsible should and must be the accepted routine in order to make these installations effective and reduce the enormous wastage which ensues when engi-

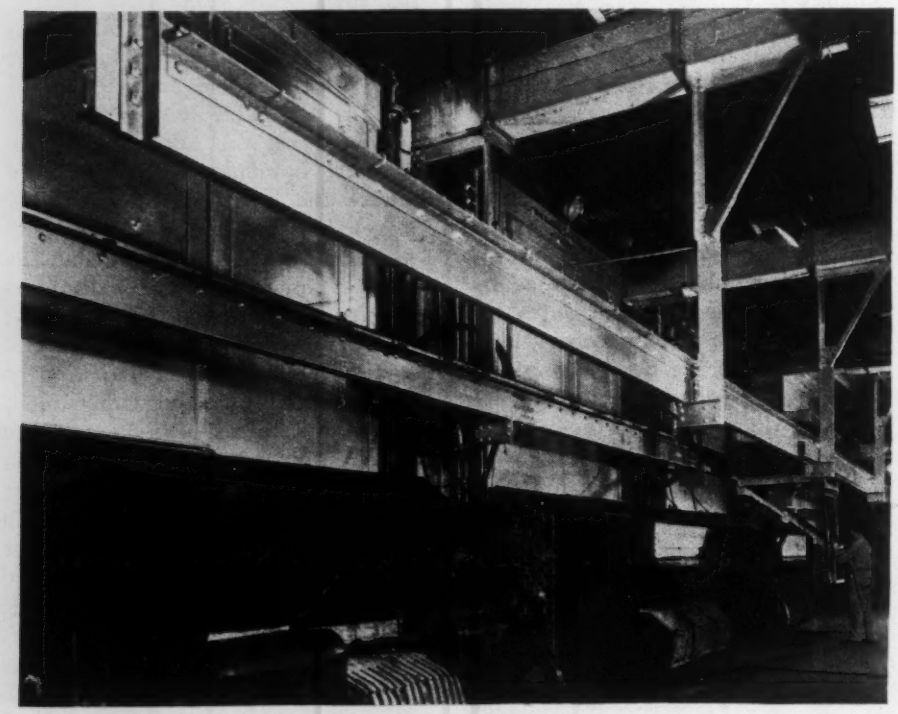
neering equipment is improperly used.

It must be said that some industrial organizations have recognized this need and do conduct intensive and elaborate schools for their maintenance and operating staffs. In exceptional cases inspection of their equipment is made periodically, but these cases are rare. An awareness must first be had of the fundamental theorem that equipment or apparatus requiring human manipulation is subject to the vagaries of attendant misuse and disuse. After this premise is established the channel through which repeated checkups are made must be agreed upon. This will involve assurance that a maintenance man receive periodic education as required to keep the apparatus performing as designed.

The whole is the sum of all its parts. Similarly, the care and use of engineering equipment is only as good as the information applied by the maintenance man on his particular equipment. The means by which this can best be done is a challenge to the engineering profession and may well be subject matter for exhaustive consideration by men competent in engineering educational fields. The challenge is twofold: To capitalize the thought and skill embodied in a given device; and to stimulate the operators so they individually will be interested in correct and intelligent operation.

The omission of proper instructional followups regarding operational techniques is typical of our national trend. Great progress has been made in the development of machines. A corresponding advance must be made in the successful operation of these machines. This involves full knowledge by the maintenance man in the manipulation and use of each piece of equipment. By this means the best social interests will be served on a national scale. Engineering research has been concerned with the development of methods and devices. A new type of investigation that will concern itself with the best use of these methods and devices is required. It is hoped that the councils of important engineering groups will give this matter immediate attention and bend their efforts wholeheartedly toward the development of needed techniques. This should result in making available the full flexibility of our complicated machines by having these machines thoroughly understood by the operators and their successors. By means of such serious consideration satisfactory methods must be evolved to insure proper operation and performance of mechanical equipment in buildings under the care of the maintenance man.

"I must condense this interesting discussion," said an engineer at a recent technical meeting, "to the items I can take home to the men on the operating floor, because it is there that the savings and economies are made."



ACTIVE CONSTRUCTION MARKET ESSENTIAL

"Construction is a basic industry in our economy. We must build before we can produce, and we must produce to be strong.

"If we look carefully at our economy, we will see that nothing is more important than a healthy building activity. The ups and downs of construction, as much as any one thing, help create the most serious threat to the continuance of our free institutions—widespread unemployment.

"Without modern factories and commercial buildings, without improved means of transportation and communication, without up-to-date housing and farm buildings and utilities—in other words without a large volume of construction—we cannot reach our postwar employment goal. To reach an output after the war of $2600, in 1941 prices, of goods and services per worker employed, inevitably will require a very active construction market, probably surpassing any previous volume."—*Eric A. Johnston, president of the Chamber of Commerce of the United States, in a speech September 25.*

OHIO STATE ADDS TO WELDING LIBRARY

All papers submitted in the James F. Lincoln Arc Welding Foundation's $200,000 award program of 1937-38, and the engineering undergraduate award and scholarship program of 1942-43 have been placed with Ohio State University's A. F. Davis Welding Library, J. R. Stitt, associate professor of welding engineering, announced last month.

The papers add substantially to the wealth of welding information in this collection, one of the largest of its kind in the world, according to Professor Stitt, who said it contains approximately 1000 books on designing for welded construction, welding techniques and procedures, properties of weld metals, standard welding handbooks, metallurgy, also magazine articles, technical papers, patents, etc.

Graphitization of Piping

SINCE THE FAILURE early last year of a 12¾ in. OD by 1-7/16 in. wall carbon-molybdenum pipe between the superheater outlet header and the stop and check valve at a large power generating station as a result of excessive local graphitization, utility operating companies have been keeping a close watch on their piping to detect any future cases before they develop into segregated graphite and a number of laboratory investigations aimed at finding the fundamental causes of graphitization and how to prevent it have been inaugurated. Examination of other steam lines at the station where the failure occurred and in other stations has revealed similar instances of graphitization, and all joints which have been found to be seriously affected have been replaced.

Graphitization is considered to be the result of the decomposition of iron carbide into ferrite and graphite. (1)* The steam pipe fracture which led to the plant and laboratory investigations of graphitization occurred around the entire periphery of the pipe at a distance of about ⅛ in. from the border of the fusion zone of the weld by which it was joined to the main steam header of the boiler. This pipe had been in service for five and a half years, at a temperature of 935 F and a pressure of 1300 psi. Examination revealed a large amount of graphite in a narrow region on both sides of the fracture; this network of graphite in the high-aluminum killed, carbon-molybdenum pipe material—which in many places was continuous—provided an easy path for fracture and was clearly the source of the failure (4).

The pipe completely separated following a tube failure in the boiler, and the immediate cause of the pipe fracture may have been shock induced either thermally or mechanically by the sudden reduction in boiler pressure from 1300 to 200 psi. The joints in this piping had been made with recessed backing rings in pipe ends which had been upset at a temperature of 2200 to 2250 F without subsequent heat treatment other than a draw at 1200 F and the usual preheating at 400 F and stress relieving at 1200 F employed in welding carbon-moly pipe (1).

Examinations made at the time these joints were welded did not disclose any evidence of graphitization or test behavior other than what would be expected of good welds or good pipe material. The subsequent graphitization is thus attributed to a sequence of events or combination of circumstances conducive to the formation of graphite through a process somewhat akin to malleabilizing cast iron. The manufacturing or processing steps which may have contributed to the failure are that the steel was killed with a large amount of aluminum, which resulted in an excess of metallic aluminum and alumina in the finished steel; the pipe ends were upset without subsequent heat treatment; a temperature of 1300 to 1400 F conducive to instability of the grain boundaries was produced in the low temperature extremity of the heat affected zone during welding; the welds were stress relieved at 1200 F, which may have affected its susceptibility to graphitization; prolonged exposure to the 935 F operating temperature resulted in graphitization; and molybdenum in itself does not afford the resistance to graphitization which is given by some other alloying elements, such as chromium (1).

*Numbers in parentheses refer to list of references.

Temperatures Which May Lead to Graphitization

Replies to a questionnaire (2) on a survey of graphitization of piping have indicated that graphite may be found in the following materials when subjected to prolonged service at temperatures in the neighborhood of those listed:

Material	Temperature, F
Carbon steel, low and medium carbon	835 ± 20
High aluminum carbon-moly pipe	885 ± 20
Low aluminum carbon-moly pipe	975 ± 20
Carbon-moly casting	950 ± 20

Note: High aluminum carbon-moly pipe had 1.5 lb or more of aluminum added per ton after deoxidizing with silicon. The low aluminum variety has about 0.5 lb of aluminum added per ton.

It should be emphasized that there are many exceptions to the findings tabulated and that graphite *may* but not necessarily *will* be found in these materials if the operating temperatures are as those given. Length of service and the extent of temperature variations above the nominal have an important influence.

The phenomenon of graphitization is not limited to welds or to upset joints, as the type of graphite formation found in the factured pipe—and which has been described as "a connected chain of segregated graphite at grain boundaries"—has also been found in a cast carbon-moly valve body adjacent to a casting-to-pipe weld.

As mentioned above, studies of this subject are being carried on both in the field and in laboratories. One fact of the survey of imme-

Since the failure last year of a large carbon-molybdenum pipe carrying steam at 935 F temperature and 1300 psi pressure in a central station power plant, there have been carried on—and are being conducted—a number of field and laboratory investigations on the subject of graphitization of piping, to which the failure is attributed. This brief article summarizes a little of the information on the subject, and suggests certain maximum operating temperatures for various pipe materials which it would be advisable not to exceed until further fundamental data are obtained . . . . . .

diate interest to operating men is the apparent desirability of limiting the extent and duration of swings above design temperatures. It is suggested (3) that, while it is not possible with available information to set definite limits for each pipe material, that it would be wise to keep below the following temperatures insofar as possible until more is known about the subject:

Material	Temperature, F
Carbon steel, low and medium carbon	850
High aluminum carbon-moly	925
Low aluminum carbon-moly	950
Carbon-moly castings	950

There is no proof that some graphite will not result under such restrictions, but on the other hand there is no indication that the serious type of segregated grain boundary graphitization will result if operating temperatures do not exceed those given.

Papers based on the work of three of the laboratories investigating graphitization were presented at the annual meeting of the ASME last December (4). Two of these papers suggest that stress relieving a welded carbon-moly pipe by heating at 1300 F for about four hours seemed to prevent subsequent segregated graphitization. Other investigators contend that the 1300 F treatment will not prevent subsequent graphitization, but that the better dispersal of carbide in the "contact zone" results in a distributed type of graphite which does not seriously impair the physical properties. These findings are being checked at the laboratories by more prolonged tests.

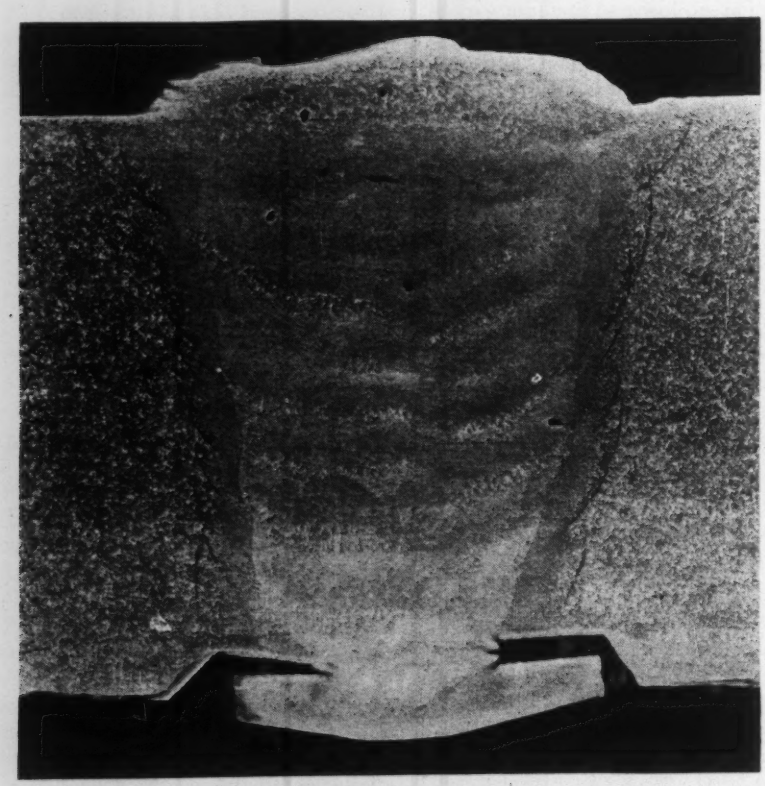
List of References

1) Circular letter to members of the prime movers committee of the Edison Electric Institute and others interested in use of carbon-moly pipe, by Sabin Crocker, chairman, subcommittee on metallurgy and piping, EEI prime movers committee.

2) Progress report No. 1 on survey of graphitization of piping conducted by joint EEI-AEIC subcommittee, of which Alex D. Bailey is chairman and Sabin Crocker is secretary. Published in Edison Electric Institute Bulletin, October 1943.

3) Progress report No. 2 of the above subcommittee, published in Edison Electric Institute Bulletin, March 1944.

4) Graphitization of Steel Piping, a pamphlet comprising four papers and discussion presented at annual meeting of American Society of Mechanical Engineers, November 29-December 3, 1943, under the auspices of the joint ASTM-ASME research committee on the effect of temperature on the properties of metals.



Welded joint exhibiting intergranular graphitization at extremity of weld heat-affected base material

PROPOSES USING WAR SURPLUS MATERIALS FOR SLUMS

Use of war surplus heating and plumbing materials for nationwide reclamation of slum areas is proposed in a joint plan supported by heating and plumbing contractors and journeymen plumbers and steamfitters, it was reported last month by the official trade paper of the National Association of Master Plumbers. The proposal anticipates considerable unemployment in the building trade during the reconversion period, continuing until construction activity reaches its expected peak level, and suggests that the plan will absorb such unemployment.

In addition to giving jobs in the building trade and improving slum conditions, the plan is advanced as a means of disposing of surplus equipment held by the military services and by governmental housing agencies.

According to the report, surpluses held by the government make the future outlook of manufacturers, wholesalers, and contractors uncertain. By reserving surpluses for slum rehabilitation, the threat to orderly reconversion of the industry is removed, it is stated.

Sponsors of the surplus disposal plan are Ralph K. Landreth, president of the NAMP, Daniel Hayes, president of the Heating, Piping and Air Conditioning Contractors' National Association; and Martin Durkin, president of the United Association of Journeymen Plumbers and Steam Fitters of the United States and Canada. The plan suggests that the contractors establish a fixed fee—below the normal rate—for their supervisory function, and that the journeymen work at a lower rate than the normal.

COMPARATIVE ENGINEERING DATA ON REFRIGERANTS GIVEN IN NEW TABLES

Engineers need information on weight and volume of a refrigerant to be circulated, and horsepower and capacity, in order to decide whether a refrigerant is suitable for a given set of circumstances. Tables of such data for a number of refrigerants have been prepared. Those for water vapor are presented here, others will appear later.

IN DECIDING which refrigerant to use under a specific set of conditions, tables are needed which give engineering data such as weight and volume of refrigerant to be circulated per ton, and horsepower and capacity. Such tables, in addition to the basic tables of thermodynamic properties, are of value in showing at a glance just which refrigerant would be desirable under a given set of circumstances. For this reason various sets of tables* have been prepared for "Freon"-11, -12, -21, -22, and -113, ammonia, methyl chloride, and water vapor. These tables enable the user to make rapid comparisons of the important basic data needed in deciding whether a refrigerant is suitable for a given set of circumstances. Temperatures are shown in degrees Fahrenheit.

The tables are easy to use. In a steam jet water cooling unit, the temperature of the make-up water to the evaporator is one of the factors that determines the volume and capacity. For centrifugal water

*See HPAC, June 1944, pp. 337-338, July 1944, p. 409, and August 1944, pp. 478-480.

Water vapor—Theoretical horsepower per cu ft of vapor compressed per min

Evap Temp	Condensing temperature 60	65	70	75	80	85	90	95	100	105	110	115	120	125
32	0.000469	0.000561	0.000653	0.000748	0.000845	0.000944	0.00105	0.00115	0.00125	0.00136	0.00147	0.00158	0.00169	0.00180
33	.000468	.000562	.000658	.000756	.000856	.000958	.00106	.00117	.00128	.00139	.00150	.00161	.00173	.00184
34	.000465	.000562	.000660	.000762	.000864	.000970	.00108	.00119	.00130	.00141	.00153	.00164	.00176	.00188
35	0.000462	0.000562	0.000664	0.000768	0.000874	0.000983	0.00109	0.00120	0.00132	0.00144	0.00156	0.00168	0.00180	0.00192
36	.000458	.000561	.000666	.000773	.000883	.000994	.00111	.00122	.00134	.00146	.00159	.00171	.00184	.00196
37	.000453	.000559	.000667	.000777	.000890	.00101	.00112	.00124	.00137	.00149	.00161	.00174	.00187	.00200
38	.000449	.000557	.000669	.000783	.000898	.00102	.00114	.00126	.00139	.00152	.00164	.00178	.00191	.00205
39	.000441	.000553	.000668	.000785	.000905	.00103	.00115	.00128	.00141	.00154	.00167	.00181	.00195	.00209
40	0.000434	0.000549	0.000668	0.000788	0.000913	0.00104	0.00117	0.00130	0.00143	0.00157	0.00170	0.00184	0.00193	0.00213
41	.000426	.000545	.000666	.000791	.000919	.00105	.00118	.00131	.00145	.00159	.00173	.00188	.00202	.00217
42	.000415	.000538	.000664	.000791	.000923	.00105	.00119	.00133	.00147	.00161	.00176	.00191	.00206	.00221
43	.000406	.000532	.000661	.000792	.000928	.00106	.00120	.00135	.00149	.00164	.00179	.00194	.00210	.00226
44	.000394	.000524	.000656	.000793	.000931	.00107	.00122	.00136	.00151	.00166	.00182	.00197	.00214	.00230
45	0.000381	0.000514	0.000651	0.000791	0.000935	0.00108	0.00123	0.00138	0.00153	0.00169	0.00185	0.00201	0.00217	0.00234
46	.000366	.000504	.000645	.000789	.000936	.00108	.00124	.00139	.00155	.00171	.00188	.00204	.00221	.00238
47	.000350	.000491	.000636	.000784	.000936	.00109	.00125	.00140	.00157	.00173	.00190	.00207	.00225	.00243
48	.000334	.000478	.000628	.000780	.000934	.00109	.00126	.00142	.00159	.00176	.00193	.00211	.00229	.00247
49	.000317	.000465	.000619	.000776	.000935	.00110	.00127	.00143	.00161	.00178	.00196	.00214	.00232	.00251
50	0.000295	0.000449	0.000607	0.000767	0.000933	0.00110	0.00127	0.00144	0.00162	0.00180	0.00199	0.00217	0.00236	0.00255
51	.000274	.000433	.000595	.000760	.000931	.00110	.00128	.00146	.00164	.00183	.00202	.00220	.00240	.00260
52	.000251	.000414	.000581	.000751	.000925	.00110	.00128	.00147	.00165	.00185	.00204	.00223	.00244	.00264
53	.000226	.000392	.000564	.000740	.000918	.00110	.00129	.00148	.00167	.00186	.00207	.00227	.00247	.00268
54	.000201	.000373	.000549	.000729	.000914	.00110	.00129	.00149	.00168	.00188	.00209	.00230	.00251	.00272
55	0.000173	0.000349	0.000531	0.000715	0.000904	0.00110	0.00129	0.00149	0.00170	0.00190	0.00211	0.00233	0.00255	0.00277
56	.000140	.000322	.000508	.000700	.000892	.00109	.00129	.00150	.00171	.00192	.00214	.00236	.00258	.00281
57	.000109	.000295	.000487	.000683	.000881	.00109	.00129	.00151	.00172	.00194	.00216	.00239	.00262	.00285
58	.0000749	.000268	.000464	.000665	.000871	.00108	.00130	.00151	.00173	.00195	.00218	.00241	.00265	.00289

Water vapor—Theoretical capacity of refrigerating compressors
(Saturated vapor leaving evaporator)
Tons per cu ft per min of vapor compressed

Evap Temp	Temperature of make-up water 50	55	60	65	70	75	80	85	90	95	100	105	110	115
32	0.00160	0.00159	0.00158	0.00158	0.00157	0.00156	0.00156	0.00155	0.00154	0.00153	0.00152	0.00152	0.00151	0.00150
33	.00166	.00166	.00165	.00164	.00163	.00162	.00162	.00161	.00160	.00159	.00158	.00158	.00157	.00156
34	.00173	.00172	.00171	.00170	.00170	.00169	.00168	.00167	.00166	.00166	.00165	.00164	.00163	.00162
35	0.00180	0.00179	0.00178	0.00177	0.00176	0.00176	0.00175	0.00174	0.00173	0.00172	0.00171	0.00170	0.00170	0.00169
36	.00187	.00186	.00185	.00184	.00183	.00182	.00181	.00181	.00180	.00179	.00178	.00177	.00176	.00175
37	.00194	.00193	.00192	.00191	.00190	.00190	.00188	.00188	.00187	.00186	.00185	.00184	.00183	.00182
38	.00202	.00200	.00200	.00199	.00198	.00197	.00196	.00195	.00194	.00193	.00192	.00191	.00190	.00189
39	.00209	.00208	.00207	.00206	.00205	.00204	.00203	.00202	.00201	.00200	.00199	.00198	.00197	.00196
40	0.00217	0.00216	0.00215	0.00214	0.00213	0.00212	0.00211	0.00210	0.00209	0.00208	0.00207	0.00206	0.00205	0.00204
41	.00225	.00224	.00223	.00222	.00221	.00220	.00219	.00218	.00217	.00216	.00215	.00214	.00213	.00212
42	.00234	.00233	.00232	.00230	.00230	.00228	.00227	.00226	.00225	.00224	.00223	.00222	.00221	.00220
43	.00243	.00242	.00240	.00239	.00238	.00237	.00236	.00235	.00233	.00232	.00231	.00230	.00229	.00228
44	.00252	.00250	.00249	.00248	.00247	.00246	.00245	.00243	.00242	.00241	.00240	.00239	.00238	.00236
45	0.00261	0.00260	0.00259	0.00258	0.00256	0.00255	0.00254	0.00252	0.00251	0.00250	0.00249	0.00248	0.00246	0.00245
46	.00271	.00270	.00268	.00267	.00266	.00264	.00263	.00262	.00261	.00259	.00258	.00257	.00256	.00254
47	.00281	.00280	.00278	.00277	.00276	.00274	.00273	.00272	.00270	.00269	.00268	.00266	.00265	.00264
48	.00291	.00290	.00288	.00287	.00286	.00284	.00283	.00282	.00280	.00279	.00278	.00276	.00275	.00273
49	.00302	.00300	.00299	.00298	.00296	.00295	.00293	.00292	.00290	.00289	.00288	.00286	.00285	.00283
50	0.00313	0.00311	0.00310	0.00309	0.00307	0.00305	0.00304	0.00303	0.00301	0.00300	0.00298	0.00297	0.00295	0.00294
51	.00324	.00323	.00321	.00320	.00318	.00317	.00315	.00314	.00312	.00310	.00309	.00308	.00306	.00304
52	.00336	.00334	.00333	.00331	.00330	.00328	.00326	.00325	.00323	.00322	.00320	.00319	.00317	.00316
53	.00348	.00346	.00345	.00343	.00341	.00340	.00338	.00336	.00335	.00333	.00332	.00330	.00328	.00327
54	.00360	.00359	.00357	.00355	.00354	.00352	.00350	.00349	.00347	.00345	.00343	.00342	.00340	.00338
55	0.00373	0.00371	0.00370	0.00368	0.00366	0.00364	0.00363	0.00361	0.00359	0.00358	0.00356	0.00354	0.00352	0.00351
56	.00386	.00385	.00383	.00381	.00379	.00377	.00376	.00374	.00372	.00370	.00368	.00366	.00365	.00363
57	.00400	.00398	.00396	.00394	.00392	.00391	.00389	.00387	.00385	.00383	.00381	.00379	.00378	.00376
58	.00414	.00412	.00410	.00408	.00406	.00404	.00402	.00400	.00399	.00396	.00395	.00393	.00391	.00389

Water vapor—Theoretical horsepower of refrigerating compressors
(*Saturated vapor entering compressor*)
Horsepower per ton

Evap Temp	Condensing temperature 60	65	70	75	80	85	90	95	100	105	110	115	120	125
32	0.296	0.355	0.416	0.479	0.544	0.610	0.679	0.749	0.821	0.896	0.972	1.05	1.13	1.21
33	.284	.343	.403	.465	.529	.595	.663	.733	.805	.878	.954	1.03	1.11	1.19
34	.271	.329	.389	.451	.514	.580	.647	.716	.787	.861	.935	1.01	1.09	1.17
35	0.260	0.317	0.377	0.438	0.500	0.566	0.632	0.700	0.771	0.844	0.918	0.993	1.07	1.15
36	.248	.305	.363	.424	.487	.550	.616	.684	.755	.826	.900	.975	1.05	1.13
37	.236	.292	.351	.410	.472	.536	.602	.668	.739	.809	.882	.956	1.03	1.11
38	.225	.281	.338	.398	.459	.523	.587	.654	.723	.793	.865	.939	1.02	1.09
39	.213	.268	.326	.385	.445	.505	.572	.638	.707	.776	.848	.921	0.996	1.07
40	0.202	0.256	0.314	0.372	0.433	0.494	0.558	0.623	0.692	0.760	0.831	0.903	0.978	1.06
41	.191	.245	.301	.359	.420	.480	.544	.608	.676	.744	.814	.886	.961	1.04
42	.179	.233	.289	.346	.406	.466	.529	.593	.660	.728	.797	.869	.943	1.02
43	.169	.222	.278	.335	.394	.453	.516	.579	.645	.713	.782	.853	.925	1.00
44	.158	.211	.266	.323	.381	.441	.501	.565	.630	.698	.765	.836	.909	0.982
45	0.147	0.200	0.254	0.310	0.368	0.428	0.488	0.551	0.616	0.682	0.750	0.819	0.891	0.964
46	.137	.189	.243	.298	.356	.414	.475	.536	.601	.666	.734	.803	.874	.946
47	.126	.178	.231	.286	.343	.401	.461	.522	.586	.651	.718	.786	.857	.929
48	.116	.167	.220	.274	.330	.388	.448	.509	.572	.636	.702	.771	.840	.912
49	.106	.156	.209	.263	.319	.376	.436	.495	.558	.622	.688	.755	.824	.895
50	0.0952	0.145	0.198	0.251	0.307	0.364	0.422	0.481	0.544	0.608	0.673	0.739	0.808	0.878
51	.0853	.136	.187	.240	.295	.351	.409	.469	.530	.594	.659	.724	.792	.862
52	.0754	.125	.176	.229	.284	.339	.396	.457	.517	.579	.645	.709	.776	.845
53	.0656	.114	.165	.218	.272	.327	.384	.443	.503	.565	.629	.693	.760	.829
54	.0562	.105	.155	.207	.261	.316	.373	.431	.491	.551	.615	.679	.745	.813
55	0.0468	0.0950	0.145	0.196	0.249	0.304	0.360	0.418	0.477	0.538	0.600	0.664	0.730	0.797
56	.0365	.0846	.134	.185	.237	.292	.348	.405	.463	.524	.585	.649	.715	.781
57	.0276	.0747	.124	.175	.227	.281	.336	.393	.450	.511	.572	.635	.699	.766
58	.0183	.0658	.114	.164	.217	.269	.325	.381	.438	.498	.559	.621	.685	.751

vapor compressors, in the row of tabulated figures headed "temperature of make-up water," use instead the temperature of the condensate leaving the condenser and entering the evaporator. The temperature of the condensate will usually be close to the condensing temperature although there may be some subcooling.

Water vapor—Weight of refrigerant evaporated
(*Saturated vapor leaving evaporator*)
Lb per min per ton of refrigerating capacity

Evap Temp	Temperature of make-up water 50	55	60	65	70	75	80	85	90	95	100	105	110	115
32	0.189	0.190	0.191	0.192	0.193	0.194	0.195	0.196	0.196	0.198	0.198	0.199	0.200	0.201
33	.189	.190	.191	.192	.193	.194	.194	.196	.196	.197	.198	.199	.200	.201
34	.189	.190	.191	.192	.192	.194	.194	.195	.196	.197	.198	.199	.200	.201
35	0.189	0.190	0.191	0.192	0.192	0.193	0.194	0.195	0.196	0.197	0.198	0.199	0.200	0.201
36	.189	.190	.191	.192	.192	.193	.194	.195	.196	.197	.198	.199	.200	.201
37	.189	.190	.190	.191	.192	.193	.194	.195	.196	.197	.198	.199	.200	.201
38	.189	.190	.190	.191	.192	.193	.194	.195	.196	.197	.198	.199	.200	.201
39	.188	.189	.190	.191	.192	.193	.194	.195	.196	.197	.198	.199	.200	.201
40	0.188	0.189	0.190	0.191	0.192	0.193	0.194	0.195	0.196	0.197	0.198	0.199	0.200	0.201
41	.188	.189	.190	.191	.192	.193	.194	.195	.196	.197	.198	.199	.200	.201
42	.188	.189	.190	.191	.192	.193	.194	.195	.196	.197	.198	.199	.200	.200
43	.188	.189	.190	.191	.192	.193	.194	.195	.196	.196	.198	.198	.200	.200
44	.188	.189	.190	.191	.192	.193	.194	.195	.196	.196	.197	.198	.199	.200
45	0.188	0.189	0.190	0.191	0.192	0.193	0.194	0.194	0.195	0.196	0.197	0.198	0.199	0.200
46	.188	.189	.190	.191	.192	.192	.193	.194	.195	.196	.197	.198	.199	.200
47	.188	.189	.190	.191	.192	.192	.193	.194	.195	.196	.197	.198	.199	.200
48	.188	.189	.190	.190	.191	.192	.193	.194	.195	.196	.197	.198	.199	.200
49	.188	.189	.190	.190	.191	.192	.193	.194	.195	.196	.197	.198	.199	.200
50	0.188	0.189	0.190	0.190	0.191	0.192	0.193	0.194	0.195	0.196	0.197	0.198	0.199	0.200
51	.188	.188	.189	.190	.191	.192	.193	.194	.195	.196	.197	.198	.199	.200
52	.188	.188	.189	.190	.191	.192	.193	.194	.195	.196	.197	.198	.199	.200
53	.188	.188	.189	.190	.191	.192	.193	.194	.195	.196	.197	.198	.199	.200
54	.187	.188	.189	.190	.191	.192	.193	.194	.195	.196	.197	.198	.198	.200
55	0.187	0.188	0.189	0.190	0.191	0.192	0.193	0.194	0.195	0.196	0.196	0.198	0.198	0.199
56	.187	.188	.189	.190	.191	.192	.193	.194	.194	.195	.196	.197	.198	.199
57	.187	.188	.189	.190	.191	.192	.192	.194	.194	.195	.196	.197	.198	.199
58	.187	.188	.189	.190	.191	.192	.192	.193	.194	.195	.196	.197	.198	.199

Water vapor—Volume of refrigerant to be compressed
(*Saturated vapor leaving evaporator*)
Cu ft per min per ton of refrigerating capacity

Evap Temp	Temperature of make-up water 50	55	60	65	70	75	80	85	90	95	100	105	110	115
32	625	628	631	634	637	640	643	646	650	653	656	659	662	666
33	601	604	607	610	612	616	618	622	625	628	631	634	637	640
34	578	581	584	586	589	592	595	598	601	604	607	610	613	616
35	557	559	562	565	567	570	573	576	578	581	584	587	590	593
36	536	538	541	543	546	548	551	554	557	559	562	565	568	571
37	516	518	520	523	525	528	531	533	536	538	541	544	546	549
38	496	499	501	504	506	508	511	513	516	518	521	524	526	529
39	478	480	483	485	487	490	492	494	497	499	502	504	507	509
40	461	463	465	467	470	472	474	476	478	481	483	486	488	491
41	444	446	448	450	452	454	457	459	461	463	466	468	470	473
42	428	430	432	434	436	438	440	442	444	446	449	451	453	455
43	412	414	416	418	420	422	424	426	428	430	432	435	437	439
44	398	399	401	403	405	407	409	411	413	415	417	419	421	423
45	383	385	387	388	390	392	394	396	398	400	402	404	406	408
46	369	371	373	375	376	378	380	382	384	386	388	389	391	393
47	356	358	360	361	363	365	366	368	370	372	374	375	377	379
48	343	345	347	348	350	352	354	355	357	359	360	362	364	366
49	331	333	335	336	338	339	341	342	344	346	348	349	351	353
50	320	321	323	324	326	327	329	330	332	334	335	337	339	340
51	308	310	311	313	314	316	317	319	320	322	324	325	327	329
52	298	299	300	302	303	305	306	308	309	311	312	314	316	317
53	288	289	290	292	293	294	296	297	298	300	302	303	304	306
54	278	279	280	281	283	284	286	287	288	290	291	292	294	296
55	268	269	270	272	273	274	276	277	278	280	281	283	284	285
56	259	260	261	262	264	265	266	268	269	270	272	273	274	276
57	250	251	252	254	255	256	257	258	260	261	262	264	265	266
58	242	243	244	245	246	247	248	250	251	252	253	255	256	257

CONTRACTORS READY FOR $11 BILLION YEARLY CONSTRUCTION

Contractors have on hand construction equipment and machinery valued at approximately $2,000,000,000, and they are prepared to handle new construction at an annual rate of from $11,000,000,000 to $12,000,000,000 within one year after the end of the war, according to the Associated General Contractors of America. Based on a recent report by the Bureau of Labor Statistics, productive capacity for all types of construction materials, except plumbing and lumber, is sufficient for a construction rate of $15,000,000,000 per year, says the AGC.

The construction industry can put from 7,000,000 to 10,000,000 people to work on construction projects on and off the site without any time-consuming retooling and reconversion of plants and equipment, the contractors' association declares.

WPB...OPA PAW...Etc.

Air Conditioning—Rules governing the production and sale of industrial and commercial refrigeration and air conditioning equipment have been modified to give them more flexibility and provide for a proper distribution to most essential users, the WPB announced August 31. While the basic restrictions of limitation order L-38, which governs this equipment, remain unchanged, the framework has been revised to permit prompt relaxations of restrictions when materials become more plentiful. Production restrictions in the order have been modified by inclusion of a schedule A in the order, and the elimination of the four lists which were previously attached to it. Schedule A gives production quotas for each type of equipment covered by the order. Those types which may not be made at the present time have been assigned a zero quota, which, when materials and parts become more plentiful, may be changed to permit production of the particular items involved. The amended order requires that a preference rating of AA-5 or higher is required for the purchase of all new air conditioning and refrigeration equipment. Furthermore, maintenance, repair, and operating supplies (MRO) ratings may be used only for the replacement of wornout equipment which has been in the purchaser's possession for at least 90 days. Certain persons, however, who are permitted to use an AA-1 preference rating for their MRO requirements will be permitted to use their ratings for minor capital additions. All applications for refrigeration and air conditioning equipment will be filed on forms WPB-1319 or WPB-617, depending upon how much construction is involved in installation of the equipment.

"Freon"—Faced with a critical shortage of "Freon-12" due to the inability of present operating hydrofluoric acid plants to fill approximately 35 per cent of their expected October quota, the commercial refrigeration and air conditioning industry advisory committee recently recommended that facilities for producing the acid be expanded and production increased, the WPB reported September 16. WPB officials reported that directives have set a deadline for the return of 2000 lb refrigerant cylinders to manufacturers. Cylinders for "Freon" must be returned in 30 days.

Heating Equipment—Eight limitation orders governing production of heating, plumbing, and cooking equipment have been amended to indicate specifically in the orders themselves that the products they cover are subject to the "spot authorization" procedure issued on August 15, 1944, the WPB announced August 30. They are commercial dishwashers (L-248); commercial cooking, food, and plate warming equipment (L-182); water heaters (L-185); oil burners (L-74); cast iron boilers (L-187); plumbing and heating tanks (L-199); coal stokers (L-75); and domestic cooking appliances and heating stoves (L-23-c).

Housing—Housing relief for congested areas was announced jointly September 16 by the WPB and the National Housing Agency. Apartment houses and other existing dwelling buildings may now be authorized for remodeling or conversion to provide smaller housing units in areas where the NHA has determined that an extreme housing shortage exists. Applications for permission to convert or remodel such structures should be filed with the nearest office of the FHA, on form WPB-2896. Approval of the application authorizes the applicant to extend a priority rating and use an allotment symbol for the purchase of his material and equipment. The applicant will be restricted to the materials and equipment permitted under the war housing critical list.

Maintenance and Repair—The WPB clarified August 29 the use of application forms by which owners or managers of commercial residential properties, home owners, and farmers may secure preference ratings to obtain materials for the maintenance or repair of residential buildings or properties. Commercial residential properties owned or managed as a business are granted an AA-5 preference rating for maintenance, repair and operating supplies under provisions of controlled materials plan regulation No. 5. Hence, the filing of a separate application form for maintenance or repair materials is not necessary. However, this AA-5 rating may not be used to obtain lumber for maintenance, repair or operating supplies, and may not always be sufficient to obtain other needed maintenance or repair materials rated on the priorities system.

Motors—Repair shops needing standard model, rebuilt fractional horsepower motors for replacement purposes may obtain information from the WPB regarding the acquisition of such motors, WPB's electrical and mechanical repair section announced September 23, by writing to W. T. Wessels, Used Motor Section, WPB, Temporary "E" Building, Washington 25, D. C.

Oil—Provision for filing of new applications for fuel oil for heat or hot water was made August 31 by OPA, and the fuel oil ration order was also amended to permit filing of renewal applications at any time (amendment 24 to revised ration order No. 11, effective September 1). Period 4 and 5 fuel oil coupons, along with definite value coupons left over from last year's ration, may be used throughout coming heating year, OPA said September 10 (amendment 25, effective September 11). Several minor changes in the fuel oil rationing regulations were made by the OPA and were effective September 22. They are: (1) Consumers who generally receive large volume deliveries or who buy heavy fuel oils requiring preheating may now have taken

into account the difference in volume of fuel oil caused by its departure, plus or minus, in degrees Fahrenheit from 60, the trading temperature of fuel oil. Coupons will be required only for the gallonage transferred to the consumer's tank after temperature adjustment changes have been made. This provision, now extended to consumers, has already been made for dealers and primary suppliers. (2) The provision requiring that fuel oil coupons be detached from a customer's sheet at the time of delivery is amended to clarify the requirement that coupons may not be detached in advance of delivery. (3) Depositing consumers—those with ration bank accounts—may, at the option of the person delivering their fuel oil, issue checks to cover deliveries as late as 15 days after delivery. Heretofore this privilege was limited to depositing consumers who received a delivery of 2000 gal or more. (4) The provisions covering deliveries where ration "evidences or credits" must be on hand before the transfer is made are clarified to include definitions of "ration evidence or credit." The responsibility of a dealer or primary supplier for determining that the customer has sufficient ration evidences or credits on hand is relaxed, except with respect to deliveries to coupon consumers, and provision is made to cover cases of delivery to persons who have become delinquent in their ration accounts (amendment 26). Another amendment covers records of primary suppliers and dealers and semi-annual statements by dealers (amendment 27, October 1).

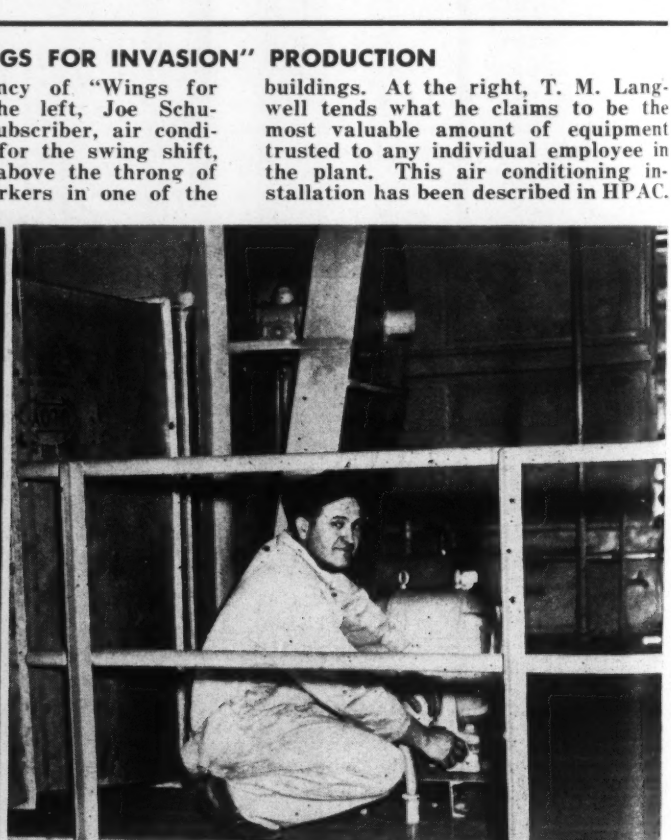
Oil—Modification of the minimum viscosity standards for various grades of fuel oils that are manufactured, delivered, or received in the Pacific Coast states was announced September 5 by the PAW.

Utilities—Construction of certain utility buildings, formerly restricted by conservation order L-41 and by utilities orders U-1, U-3 and U-4, is now restricted only by the utilities orders, the WPB reported September 23. The change was made by amendment to L-41, which eliminates such construction from restrictions of that order. By utility construction is meant any building or group of buildings to be used directly in furnishing electric, gas, water, central steam heating, or wire communications services (telephone or telegraph). To make Office of War Utilities procedure conform to policy established in "G. I. Bill of Rights," extensions of electric, gas, water, and central steam heating services to hospitals and other Veterans Administration facilities may be made on the same blanket basis as extensions of such services to Army and Navy facilities, OWU announced, with the issuance of supplementary utilities order U-1-a amended September 21. Electric power, water, natural and manufactured gas, and central steam heating public utilities have been granted the right to make certain minor plant additions and extensions up to $10,000 in material cost, without obtaining approval from Office of War Utilities, OWU announced August 31.

Welding Equipment—The WPB revoked September 5 limitation order L-268, lifting restrictions on the use of nonferrous metals in the production of oxy-acetylene apparatus used in welding, heating, spraying or cutting of metals. This order is superseded by order L-123.

AIR CONDITIONING AIDS "WINGS FOR INVASION" PRODUCTION

At the Douglas Aircraft Co. Long Beach plant in California, each building has one attendant on each shift whose sole duty it is to check and service the heating and air conditioning equipment which is so vital to production efficiency of "Wings for Invasion." At the left, Joe Schumacher, HPAC subscriber, air conditioning operator for the swing shift, does his job far above the throng of assembly line workers in one of the buildings. At the right, T. M. Langwell tends what he claims to be the most valuable amount of equipment trusted to any individual employee in the plant. This air conditioning installation has been described in HPAC.



Heating, Piping & Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

Altitude Chamber for Study of Heating and Air Conditioning Problems

By W. E. Crowell,* Buffalo, N. Y.

SUMMARY — This paper presents some of the problems encountered in high altitude flight and shows how the altitude chamber may be used to solve many of them. The answers to these problems are gradually being worked out by the aircraft and aircraft accessory manufacturers.

THE PURPOSE of this paper is not to give the answer to some problem but instead is to present problems which require answers. It is also presented to describe one device which is being widely used in solving these problems.

It may seem strange to start a discussion such as this by going back to the year 1862, but actually the first notable flight by man to high altitudes occurred in that year. Glaisher and Coxwell, two French balloonists, made an ascent in a balloon to approximately 29,000 ft and encountered severe physiological symptoms which later were to be the subject of much study by flight surgeons. As they ascended, Glaisher noticed his vision and hearing failing, next he became paralyzed in his legs and arms, and finally became unconscious. At the same time, his companion Coxwell encountered the same troubles, but with great presence of mind he pulled the dump valve with his teeth (his arms were paralyzed) and descended to a safe altitude.

A few years later, three other men, Tissandier, Crocé-Spinelli and Sivel, made a high altitude balloon flight which ended in partial disaster. All men lost consciousness at 26,000 ft but the balloon ascended to 28,820 ft and then descended on its own accord. Tissandier was the only one to recover.

Such flights attracted the attention of Paul Bert, a famous French physiologist, and he began a study of the effects on the human system of increased and decreased barometric pressures. As one of his laboratory devices, he used a steel tank large enough to accommodate a single person plus the necessary instruments. This, to the best of my knowledge, was the first altitude chamber.

Today there are probably 40 or 50 large altitude chambers in this country alone and hundreds of smaller ones.

Up until the present war only a handful of men and machines had ever gone above 25,000 ft. Consequently, the information available concerning high altitude operation was scarce. With the coming of World War II, however, high altitude operations of bombers and fighters became a regular thing. But it wasn't a case of designing planes on the board, building them and sending them over Europe to operate in 500 or 1,000 plane raids. Our *Flying Fortresses* had been designed several years before the war and were supposed to be the best high altitude bombers in the world, yet when they first went into combat it was in very small numbers and the difficulties which arose were tremendous.

These problems have been studied in the past by two general methods of testing, flight tests and ground tests.

Flight tests usually consist of installing the equipment to be studied in the airplane in the same manner as it will be installed when put in production, and then instrumenting it as much as is required to give accurate performance data and as well as the arrangement will permit.

Ground tests are of various types, some of which may be made with the apparatus installed in cold boxes, cold rooms or bell jars, size permitting. Instrumentation and control of conditions in general can be better than in flight testing,

*Section Head, Altitude Chamber Structures Dept., Curtiss-Wright Corp.

For presentation at the 51st Annual Meeting of the American Society of Heating and Ventilating Engineers, Boston, Mass., January 1945.

although many assumptions may have to be made of some of the conditions.

As more and more of this testing had to be done, it became apparent that the above methods were inadequate for thorough studies of the problems. Flight tests generally did not permit accurate enough instrumentation or control of conditions, and ground tests could not duplicate all the required conditions. What was needed was a testing device which would exactly duplicate on the ground the high altitude conditions encountered in flight. Actually this would require a huge full scale wind tunnel in which air speeds, temperatures, pressures and humidities duplicating those at any desired altitude could be controlled. Obviously this would be an extremely costly piece of apparatus beyond the price range which any aircraft manufacturer could afford. The majority of equipment on an airplane, however, is enclosed within the fuselage or wings and is not directly affected by outside airspeed. If airspeed can be eliminated, then the testing device can be built as an enclosure in which the other conditions are maintained as desired. This type of device is much less expensive than the do-all wind tunnel. Certain conditions to be met by such equipment are:

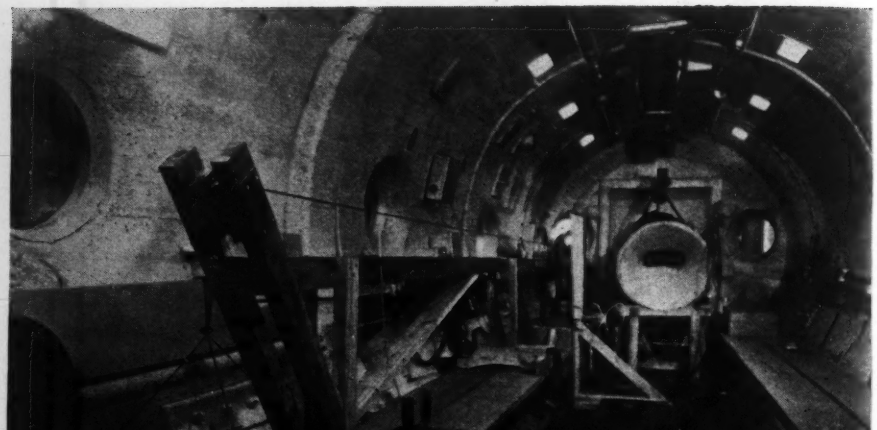


Fig. 2—Interior of altitude chamber

1. It must have complete instrumentation.

2. The desired conditions must be closely controlled.

3. Total operating cost must be as low as possible. It has been the experience of one aircraft company that experimental flight testing of large twin engine airplanes costs roughly $1000 overall for a 3 or 4 hour flight whereas the overall cost of operating a large altitude chamber is about $35 per hour.

4. The equipment must have all possible provisions for the safety of the operating personnel especially since it will often be necessary for some persons to be subjected to high altitude conditions.

5. Provisions should be made for making tests as quickly as possible. This will require that shop facilities be immediately available and that the conditions of operation be obtained quickly.

6. Provisions should be made so that wherever possible persons may observe the performance of the equipment being tested without subjecting themselves to high altitude conditions.

7. The apparatus must be suitable for teaching fliers how to use oxygen equipment and how to protect themselves at high altitudes. Simulated high altitude conditions in the chamber are needed to enable the fliers to apply the instructions received.

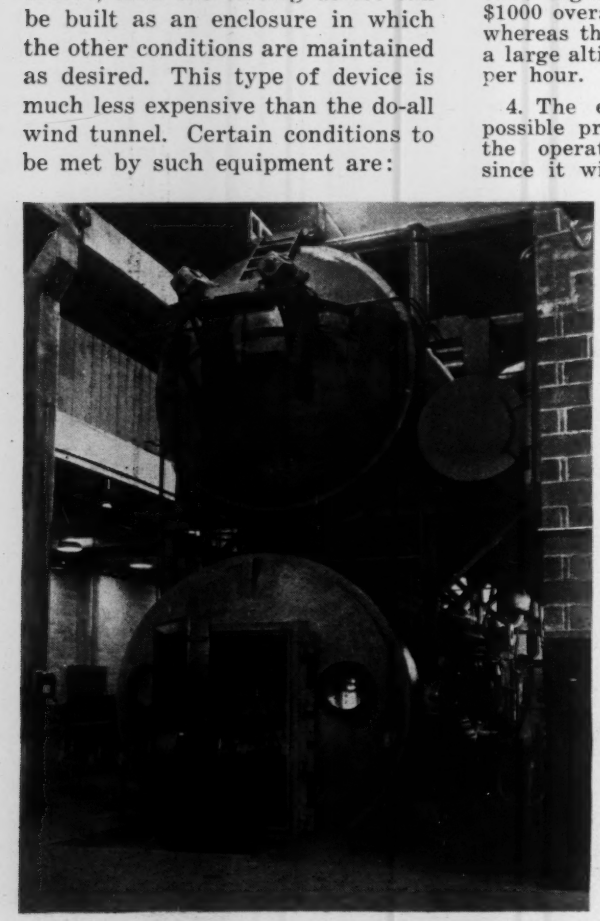


Fig. 1—External view of altitude chamber

Several aircraft and aircraft equipment manufacturers have seen the need of such a device and have been attracted by the possibility of safer, less expensive, and more accurate high altitude testing. Since various companies had different ideas about the size of testing space, maximum conditions required, and limit of expenditure, it became apparent that each altitude chamber would be a tailor-made job. Smaller sized high altitude testing cabinets have become somewhat standardized, but no two of the larger sized altitude chambers are similar.

Description of Altitude Chamber

The altitude chamber at the Curtiss-Wright Research Laboratory in Buffalo is a good example of the larger sized chambers and a description of it is of interest.

Fig. 1 is an external view of the chamber showing the two shell arrangement. The upper shell, which is 10½ ft in inside diameter, contains all the evaporator coils and the cold air circulating fans driven by four variable speed induction motors, two of which are shown in the photograph. The lower shell or main test chamber is 10 ft in inside diameter and is connected to the upper shell by two large ducts. Each duct contains two sections for the cold air which is blown down from the evaporator coils and a center section through which the

returning air can again pass into the upper shell. Dampers in these ducts actuated by a compressed air diaphragm motor accomplish the major part of the temperature control.

The large door shown in the end of the chamber is 4 ft x 7 ft and will allow passage of the complete fuselage of a pursuit type airplane. If the object being installed in the chamber is too large to pass through this door, the whole end of the chamber may be removed.

Two of the observation ports of the main test chamber are shown at the end of the chamber. Five of these are 18 in. in diameter and one is 24 in. x 18 in. oval. Two ports of 10 in. diameter are in the small man lock at the opposite end of the chamber. Each port is built up of five plates of glass with a dehydrated air space between each plate. The main control panel is shown at the right of the chamber.

Fig. 2 shows the interior of the test chamber, which is 10 ft in diameter by 30 ft long. In the background is a test setup for carburetor de-icing tests, while on the left is a test jig for determining the coefficient of expansion of an aircraft control cable. In the upper right of the picture are shown the cold air ducts with deflectors and the electric unit heaters which are connected to the automatic temperature control.

Cork insulation is installed inside the chamber in order to reduce the heat load given off by the steel shell when the chamber air is suddenly cooled down. This cork is 6 in. thick and installed without any adhesives or fasteners by using the principle of an arch. Insulation, 2 in. thick, is installed on the outside of the shell. The upper shell, which holds the cooling coils, is insulated in the same manner.

Fig. 3 shows the main control station. The large oval port in front of the operator permits observation of a large part of the test chamber. Push buttons for the refrigeration equipment and vacuum pumps are located on this panel. The three air operated controllers control the rate of climb, temperature, and pressure automatically. The operator is in constant communication with persons inside the chamber with the man lock operator and the medical observer. Other sets of instruments which apply to the equipment being tested are usually located to the right of this main control station.

It is sometimes necessary for persons to enter or leave the main test chamber while it is at altitude conditions. In order to do this they must first enter the man lock, which is a small chamber attached to one end of the main chamber. If they enter from the main chamber, then the man lock pressure is first made equal to the chamber pressure. After entering the man lock, the men close the door through which they have just passed and then the man lock pressure altitude is lowered. When the pressure equals atmospheric pressure, the outside door may be opened and the men step out. If simulated altitudes are high enough during this operation the men carry portable walk-around oxygen bottles when transferring from the main chamber to the man lock.

Fig. 4 shows the control station for the man lock. The operator who controls the vacuum and bleed in air manually is in communication with the persons inside the chamber as well as with the main control station operator and the Medical Doctor.

The refrigeration equipment consists essentially of a three stage compression system using Freon-12 as a refrigerant. It develops a total of 36 tons of refrigeration with an evaporator temperature of —85 F. The rotary vacuum pumps for creating simulated high altitude total 150 hp and they can be arranged for parallel single stage operation or for series two stage operation.

With all of the foregoing equipment, performance becomes quite remarkable. Secrecy forbids publication of the maximum altitude or the minimum temperature which this altitude chamber can produce, but a brief statement of the requirements of one of the acceptance tests for this equipment will give a good idea of its performance. There was to be installed in the chamber during such a run the

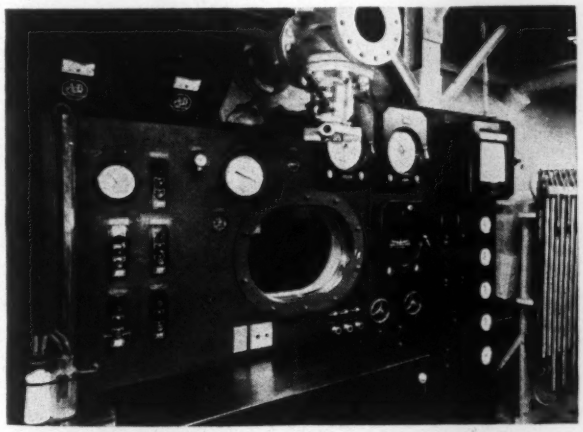


Fig. 3—Control station outside of altitude chamber

Fig. 4—Control station for man lock

fuselage of a pursuit airplane plus its mechanical equipment which gave off a specified heat load. It was required that the altitude in the chamber be raised from ground level to 35,000 ft and at the same time that the temperature be dropped from +60 F to —70 F in a period of nine minutes. Just imagine an airplane trying to match that performance in climbing to high altitude.

Effect of Altitude on Man

Let's review briefly some of the problems encountered by men and machines at high altitude. Some of these will be more or less familiar to heating and air conditioning engineers; others will be entirely new.

First of all, let's take the human being. Man is definitely a ground animal and he can only adapt himself to reasonable changes from his natural environment.

Oxygen Requirement

Man requires additional oxygen if he goes above 10,000 ft for any length of time, and even when breathing 100 per cent pure oxygen, he cannot live at an altitude much above 40,000 ft without special means, because the atmospheric pressure at that altitude is too low to force sufficient oxygen into the blood stream at the lungs. In order to exist at an altitude much higher than 40,000 ft, the flier must be surrounded by a local atmospheric pressure sufficient to force the oxygen into the blood stream. This is accomplished by using pressurized cabins, pressurized suits and other pressuring means. Two Army Air Corps men, Stevens and Anderson, have reached an altitude of 72,395 ft in a balloon fitted with a spherical gondola which was pressurized and air conditioned.

Temperature Requirement

Another change of which man can tolerate very little is that of temperature. He must be supplied with added heat or clothing if his skin temperature drops much below 88 F and must have external cooling if his skin temperature rises much above this figure. Clothing is used as an insulation against changes of temperature. This gets very bulky if it is sufficient to insulate for temperatures as low as —70 F, which are often met in the stratosphere. (Actually temperatures of —110 F have been found in the stratosphere.)

Aeroembolism

Aeroembolism is another factor which makes it discomforting and even hazardous for man to climb to high altitudes. Aeroembolism is an illness similar to the diver's *bends* and generally occurs only above 28,000 ft altitude. It is generally considered to be caused by the gases which are normally entrained in the blood stream and tissues coming out of solution and forming bubbles. These bubbles often collect near the joints and under the skin and become either annoying or extremely painful, depending on the severity of the condition. The only known remedy at present is to increase the pressure of the atmosphere around the person in order to put those gases back into solution. This is done either by pressurization such as with pressure cabins or by descending to a lower altitude where the pressure is greater.

Almost everybody is familiar with ear trouble which occurs with rapid changes of altitude or pressure. The sinuses are similarly affected by these changes. Another result of pressure change is the expansion of abdominal gases. If these cannot be readily relieved, they become pocketed, and as the pressure surrounding a person is lowered, the gas in the pocket expands and causes distension of the bowels which if carried very far becomes painful.

Dry Oxygen and Air

Fliers who have breathed oxygen for a long time such as on long bombing missions are often aware of a raw throat and nostrils due to the breathing of bone dry oxygen. Oxygen has to be bone dry so that it won't freeze in the regulators. Not much experience has yet been accumulated on pressure cabins for airplanes, but it is predicted that dehydration of the personnel in these cabins may be a serious problem when flying at high altitudes unless some arrangement is made to humidify the air. At +70 F and sea level saturated air has about 8.00 grains of moisture per cubic foot, but at —60 F and 33,000 ft altitude it has only 0.01 grain per cubic foot. At lower temperatures than this, the amount of moisture is nil. Since the cabin supercharger must take this very dry air from the surrounding atmosphere to pressurize the cabin and make up for ventilation and leaks, it is evident that a real problem is created.

Other factors such as acceleration, effect of noxious gases, use of drugs and a few others should also be included in the list but are not discussed in this paper.

Effect of Altitude on Equipment

High altitude problems are not limited entirely to physiology of human beings. Man made machinery is even more troublesome. Most materials become very brittle at cold temperatures. Ordinary rubber hoses crack when flexed and some metals become brittle as glass and shatter on impact.

Expansion and Contraction

The difference in the rate of contraction or expansion of materials also presents a serious problem because of the wide temperature ranges encountered and the close fits of many parts, such as in gun and turret mechanisms and the hundreds of other precision parts which go into an airplane. The ambient temperatures encountered may vary from as high as 120 F on the ground to —100 F in the stratosphere. Under such conditions, close fitting parts made of materials with dissimilar coefficients of expansion may sieze.

Viscosity of Oils

The change in viscosity of oils and other fluids presents a serious problem in aircraft where the ambient temperature may change from +100 F on the ground to —70 F in the stratosphere in a matter of a few minutes. This fact has led to considerable research in the development of hydraulic fluids and greases for aircraft.

Electrical Equipment

Electrical equipment at high altitudes is likewise troublesome. Due to low pressures, sparking and corona discharge are more severe and require heavy insulation of various parts such as spark plug cables or even pressurization of

them. Bad radio interference results if this is not remedied.

Excessive wear of brushes on d-c generators has been found at high altitudes. The major cause is generally conceded to be lack of humidity in the air. Moisture or moisture combined with other things is a lubricant. Without it excessive friction and wear will occur.

Miscellaneous Problems

There are many other problems too numerous to discuss in detail but some of these should be mentioned. They are: icing and fogging of windshields and windows; devising suitable controls and seals for pressurized cabins and methods of supercharging engines and pressure cabins; and trouble with communication systems, particularly microphones.

The studies of carburetor icing, coefficient of expansion of materials, and of many physiological problems not yet mentioned have also been successfully carried out in altitude chambers.

Heating Airplanes

Some of the problems encountered in high altitude flight are more or less familiar to heating and ventilating engineers. Airplane heating is one of these. Off-hand it may look like a fairly simple job to install a heater and some ducts in an airplane and thereby obtain satisfactory heat. One of the first considerations confronting the designer is that of weight. Aircraft engineers are well aware of the saying *$100 a pound.* It means that for every pound of dead weight saved, the earning capacity of the airplane is increased $100 during its lifetime. Some airline operators think $200 a pound is nearer the correct value.

The constant struggle is to achieve the optimum balance between weight and comfort. Where you try to save weight by making the ducts smaller and selecting the smallest heater possible, sometimes you find that the smallest heater is the least efficient or has the least output so you try to counteract that by insulating the cabin. Immediately up goes the weight again.

At high altitudes, the skin of the airplane gets very cold; in fact, nearly as cold as the outside air. This brings the *cold wall effect* into the selection of comfort conditions. Radiation from a man's body to the cold wall is quite appreciable and insulation must again be considered. So important is this *cold wall effect* that cabin temperatures taken during acceptance tests for aircraft heating systems are sometimes obtained by installing the thermocouples in small aluminum blocks painted dull black. This method will give a reading lower than the actual air temperature but will be a better indication of the degree of warmth felt by an individual inside that cabin.

The very fact that the atmosphere is less dense at high altitudes makes it difficult to heat the cabin by convection. Pressurizing the cabin would of course eliminate this particular problem.

While it is not within the scope of this paper to discuss in detail the various types of heaters being used, two popular types will be mentioned: the gasoline fired heater and the exhaust gas heat exchanger. The gasoline fired *heater,* Fig. 5, burns regular aviation gasoline and is very light and compact, enabling it to be tucked away in small spaces near the spot to be heated. Fig. 6 shows this same heater undergoing tests in an altitude chamber. This unit consists of three separate heaters totaling 240,000 Btu per hr. The altitude chamber can be very helpful as an aid to the development of aircraft combustion heaters. Tests in the chamber proved that the heaters would burn without supercharged combustion air at altitudes **higher than** any regular military or commercial plane has flown. They also revealed many weaknesses in the accessory equipment which would normally be discovered only after months of actual service.

The *exhaust gas heat exchanger* takes waste heat from the engine exhausts and distributes the heated air in ducts to the points of application. This device requires no extra fuel, is simple to operate and has an ample amount of heat available during most flight conditions. Objections to this system have been primarily the added weight of ductwork necessary and the failure of the heat exchangers due to corrosion and vibration. If a plane is originally designed for this type of system, the added weight of the ducts can be much less than if an existing plane has to be modified. This system is used successfully in some German planes.

Pressurized Cabins

Mention was made earlier in this paper of pressurized cabins for aircraft. While these eliminate many physiological problems, they do add others both physiological and mechanical. The question usually asked when pressure cabins for military aircraft are mentioned is *What happens when a shell hits it?* This problem was one which had to be solved before the B-29 Super Fortresses could be put into combat operation. The sudden reduction of cabin pressure resulting from the

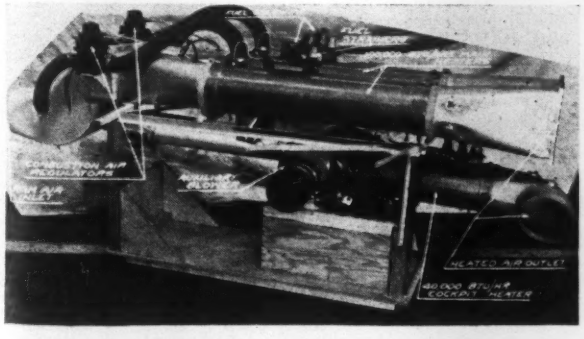


Fig. 5—Gasoline-fired airplane heater

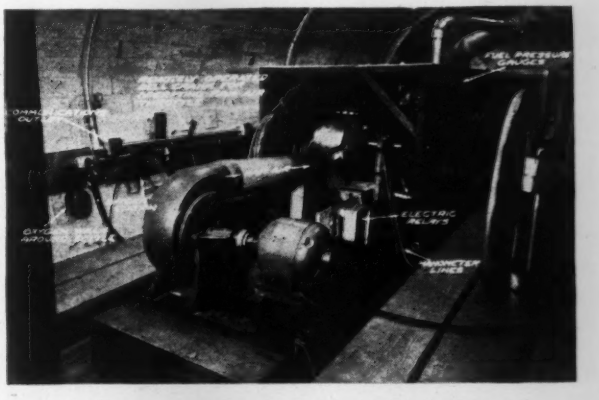


Fig. 6—Test arrangement for airplane heater

puncturing of a pressure cabin is termed *explosive decompression.* Although the details on "explosive decompression" cannot be revealed for security reasons, the author can say from personal experience that such an encounter is not fatal.

Most of the work on this physiological problem has been done by the Army Air Forces Aero-Medical Laboratory in altitude chambers.

Much remains to be done in the field of passenger comfort at high altitudes and it is going to take engineers who are familiar with both airplane design and heating and air conditioning to do a good job. The altitude chamber will be a very useful instrument for aiding in the solution of this problem and others caused by high altitude.

THAT WONDERFUL, WONDERFUL POSTWAR WORLD

BY GEORGE D. WEVER

Listen, my children, and you can hear
Through the opium-laden atmosphere
The voices of soothsayers, prophets and seers
All fortune-telling the Postwar years.
How the world as we know it will suddenly cease
'Ere the ink is dry on the Treaty of Peace,
And, presto—a new world? Our homes, our cars,
Will look like something fresh out of Mars,
And you'll casually step in your autogiro
For 18 holes of golf in Cairo.

You'll live on pills. You'll carry your bride
To a home made of phenol-formaldehyde,
With electronic beams to do the chores,
Electric eyes to open the doors,
And radar (that newest of trouble detectors)
To warn of approaching bill-collectors.

Or we won't have homes—we'll live in trailers
With six rooms furnished by Lord and Taylor's.
And everyone, even in Winnepesaukee,
Will own television and walky-talky.
And this, good friends—this prospect bright—
Is to happen suddenly, quite overnight.
Is it true or false? Or a glorious hoax?
(It's just a lot of malarky. folks.)

COAL RESEARCH A CENTURY AGO

The year 1944 marks the hundredth anniversary of the publication of a remarkable study of American coals carried out by Professor Walter R. Johnson at the Navy Yard in Washington, to determine the relative suitability of a variety of coals for steam raising, and to provide a basis for purchasing fuel for Navy vessels. So far as can be determined, this is the first example of coal research carried out in the United States, says Bituminous Coal Research.

In response to widespread announcements inviting the submission of samples, forty-one lots of coal were obtained and subjected to test. Nine were anthracites from Pennsylvania, twelve were semi-bituminous coals, of which half were from the Cumberland region of Maryland and half were from Pennsylvania. Eleven bituminous coals were examined, all from the Virginia fields (which included West Virginia). To complete the tests, six different foreign coals and two western coals were evaluated. Of the latter, one was from Pittsburgh and the other from Cannelton, Ind. Similar tests were also run on pine wood, two "species" of coke, mixtures of bituminous coal and anthracite, and a sample of "natural coke" from Tuckahoe, Va.

Professor Johnson ran full-scale determinations of the evaporative power of the fuels, when burned under a boiler, as the basis for evaluating their usefulness. Each experiment consumed an average of 1000 lb of fuel and lasted for a period of 12 to 14 hr, during which continuous observations were made of temperatures of incoming air, flue gases, steam in boiler, and water supply. Total weights of clinker and ashes produced were determined and net weight of water evaporated was calculated.

Tables were published rating the coals in the order of their evaporative power, and an attempt was made to classify them according to their proximate and ultimate analyses. Professor Johnson devised the system of classifying coals according to the ratio of volatile to non-volatile combutible constituents, a system which is still in use for this purpose. His report was published in a 600-page volume of which 11,000 copies were ordered by the 28th Congress to be printed and distributed. Only a few copies are still in existence.

RULES FOR WELDING MARINE PIPING

Rules for Fusion Welding Piping in Marine Construction, first published in 1938, has been revised to bring the original data for welding low carbon steel (0.35 per cent max.) marine piping up to date. Among the topics included are qualification of welding procedure, qualification of welding operators, design, layout and dimensions of piping, allowable types of joint, preheating, stress relieving, radiographic tests, and hydrostatic tests.

Copies of the standard are available in the form of a 6 x 9 in., 4 p. bulletin from the American Welding Society, 33 W. 39th St., New York 18, N. Y., for 25c.

BUY AND HOLD WAR BONDS!

Fifty Years of Progress in Ship Ventilation and Heating 1893-1943†

By John W. Markert*, Washington, D. C.

THE 50-YEAR period between 1893 and 1943 produced many entirely new methods and extensive applications of ventilation and heating in all types of ships.

Natural ventilation by means of cowls, skylights, and airports was generally used for ship ventilation previous to 1893, while stoves, hot water and steam pipe coils were commonly used for heating. The ventilation systems of the *Oceana* and *Arcadia* of the P and O Co. (1885) were exceptions, as these vessels were provided with a combined plenum and vacuum system, in which *jets of compressed air at 4 psi* were used to induce air flow in the ducts. This arrangement was considered much more effective than that in two similar vessels equipped with a vacuum system, in which the vacuum was produced by a reciprocating vacuum pump.

The paddle steamer *Princess May* (1892) was another exception, because *mechanical ventilation* was provided by steam engine driven fans for the cattle spaces. This vessel was also unusual in that heating by means of *steam pipe coil radiators* was provided for steerage and crews' quarters as well as for the saloons.

The record shows that the U. S. Coastline Battleship *Indiana* (1893) had a "thorough system of ventilation, and air could be forced into or drawn out of any part of the vessel by steam-driven fans." While it is not clear just what system was employed to achieve this ventilation, it should be noted that the so-called *American* system of heating and ventilating used at that time consisted of a supply fan which discharged the air into foyers and passageways from which the air flowed into the staterooms via louvers. Either natural or mechanical ventilation was provided to extract the vitiated air directly from the staterooms. Heating was accomplished by blast coils consisting of steam heated pipes installed in the ducts. Among the first passenger ships to have this system of ventilating and heating, and employing motor-driven fans, were the *St. Louis* and *St. Paul* of the American Line (1895).

One of the earliest efforts in *sound proofing* was probably that made in the Cunard Twin-Screw Steamer, *Compania* (1893), which had a double casing around the machinery space *filled with material to reduce heat and sound.*

In 1893 W. Tattersall, Accrington, Lancashire, England, patented a propeller fan, which had four bucket type blades, and was not self-propelled. This type of fan (electrically driven) was first used on the Union Line Twin-Screw Steamer, *Norman*, in 1894, for exhausting air from passageways and public rooms into the stokeholds. In this ship the drawing room was *air-cooled* by circulating cooled brine through the hot blast heating coils.

The introduction of tankers presented a new application for ventilation. In 1894 a system was patented which ventilated the oil tanks by means of the cargo oil lines through which steam-driven fans supplied 2000 cfm of air at 16 in. pressure.

Prior to 1894, *fans were driven by steam engines.* The introduction of electricity into ships caused a rapid change to motor-driven fans so that by 1895 they were rather common, except in forced draft equipment. Some designers preferred to retain the steam engines because the exhaust steam could be used in the hot blast coils. Motor-driven fans were used by the U. S. Navy in 1895.

The cruiser, *Terrible* (1895), was probably the first British warship provided with mechanical supply ventilation to all spaces below the protective deck.

While the records are somewhat confusing, it seems probable that *electric convector heaters* were used on the *S. S. Oceanic* and *St. Paul* (1895). It appears that these applications were experimental and were used to overcome some of the faults of the *American* system. *Thermostatic control* of the electric heaters was tried with varying degrees of success. Even at this early date the economy of thermostatically controlled heating systems was appreciated and was particularly emphasized by the manufacturers of electric heating equipment in order to offset the high cost of producing electricity compared with steam.

Among the several new systems introduced by 1900 was the *reverse system*, one of the earliest applications of which was made on the Cunarder, *Invernia*. This system included a fan, pipe coil air heater with steam traps, and by-pass and other dampers so arranged that hot air was supplied directly to the space when heat was required, and vitiated air could be extracted directly from the space (by manipulating the dampers and using the same fans and ducts) when ventilation was desired. Air supplied to, or exhausted from, adjoining passageways and corridors by natural means completed this system, which was most popular in Europe. As there were no means for automatically controlling the hot air temperature, manual control of by-pass dampers was necessary to achieve the desired result. In 1900 thermostatic controls of the pneumatic type were first used to regulate the

†Presented at a meeting of the New York Chapter.

*Chief Ventilation and Heating Branch, Technical Div., U. S. Maritime Commission. Member of ASHVE.

heating system on three German passenger vessels.

Another system was the *double (dual) duct system* which is still popular. This system consisted of a fan and twin discharge ducts, each of which distributed air to the respective spaces. One duct was fitted with hot blast heating coils. By means of this arrangement, the temperature of the heated space would be varied by adjusting the volume of hot and cold air entering the space. As an improvement of this system a tempering coil was introduced in the cold air duct to prevent cold blasts of air from reaching the heated spaces. While this system was not common on ships in 1900, it had been installed on the *H. D. M. S. Zeehond* and the Japanese battleship *Asahi*.

The double duct system overcame the difficulty of heating and ventilating inboard and outboard staterooms with the same system. Outboard staterooms required much more heat while the inboard staterooms required much more ventilation (natural ventilation being limited by the lack of airport and similar openings).

A third system which obtained good results and which is most common today "blew warm air directly into cabins, etc., and allowed the vitiated air to pass into the passage and find its way out. . . ." Several cruisers in the Dutch Navy (prior to 1900) were ventilated and heated in this manner.

At this time (1900) *duct velocities* between 2000 and 2400 fpm velocity were common though very little specific data on duct losses were available. Shortly before this time a series of tests was run to convince the Russian Navy of the superiority of hot blast heating. The *S. S. Kostroma* was fitted out with hot blast heating and the *T. S. S. Moskva* with a steam pipe coil heating system. The tests showed that the hot blast system produced 26 F rise in 1½ hours while the steam system obtained only a 4 F rise in the same time.

The fact that inside staterooms always have been unpopular is well known. The Bibby Line arrangement introduced shortly before 1901 is an example of the numerous schemes used to obtain *all outside staterooms*. This arrangement provided a narrow passage between the stateroom (inboard) and the ship's side, at which point an airport was fitted.

The introduction of motor driven equipment had an appreciable effect on the design of ventilation systems, particularly on warships. With engine driven fans it was necessary to use a few large units with long distributing ducts, in order to reduce steam piping to the engines. The ducts frequently pierced watertight structures, thus necessitating the use of many watertight closures. When motor driven fans were made available, the practice changed and many smaller fans were used in order to eliminate the long runs of ducts and watertight closures. A notable example of this is the *U.S.S. Olympic*, in which, when it was remodeled about 1902, the two original steam driven fans were replaced by nine electrically driven supply and exhaust fans.

In 1903 *cast-iron radiators* were introduced and effected a reduction in weight as they were far more efficient than the pipe coil radiators common at that time. Radiators were used for heating some of the spaces on the *U.S.S. Battleship Virginia* (1905).

An article published in 1904 indicates that the introduction of submarines presented new ventilation problems. Referring to Dutch submarines, this paper states, "The ventilation arrangements, both on the surface and submerged, are also declared to be bad." Another paper published in the same year reported that mechanical ventilation was provided for the holds of the Anchor Line vessel, *Italia*.

In 1905 Admiral D. W. Taylor presented his classic work, *Experiments with Ventilating Fans and Pipes*, to the *Society of Naval Architects and Marine Engineers*. This paper described the results of approximately 15 years of research and experimentation. Admiral Taylor introduced the present standard method of testing fans, which was radically different from the method used at that time and therefore was violently opposed. The paper also revolutionized the fan industry and emphasized the value of the Pitot tube for air measurement. This study also included a scientific investigation of friction and other duct losses and was probably the first complete work on the subject.

The results of Admiral Taylor's investigation were reflected in the design of the U.S.S. Armored Cruisers, *West Virginia* and *Maryland*, in which various combinations of natural and mechanical ventilation were utilized depending on the particular nature of the space served. In the engine room mechanically supplied air was distributed to the watch stations.

The S.S. *Lusitania* and *Mauretania* (1907) were ventilated and heated by the reverse system, which was used for both passenger and crew accommodations. Electric fans were used and the heaters operated on 30 psi steam pressure. Exhaust ventilation was provided for galleys, pantries, baths, and similar spaces. Because of heating difficulties dual duct systems were provided for the inside staterooms after these ships had been in service a short time.

By 1908 *bracket fans were quite popular*, and *electric punkahs* were used on the *S.S. Omrah*. The latter consisted of a fabric screen supported by a horizontal shaft attached to the ceiling. The shaft was linked to an electric motor in such a way that the screen oscillated to create a movement of air.

Ozone was first used on the *S.S. Makura* in 1908, for purifying the ventilation air supplied to the cabins. In 1913 it was used on the *S.S. Imperator*. This vessel was also notable for the fact that it was the first one which did not use cowl ventilators. The *Kaiser Franz Josef I* (1911) was equipped with both steam and electric heating.

The *Aquitania* and *Transylvania* (1914) had reverse ventilation systems, and heating was accomplished by means of a two pipe steam heating system with radiators operating under 5 psi steam pressure. A special type fan was used to ventilate the engine rooms. This fan was similar to a backward curve centrifugal fan without a casing. Each fan was mounted vertically in the engine room at the lower end of the intake trunk so that the air was diffused by the fan.

In 1923 a steam jet refrigeration machine was invented and patented by the *Société des Condenseurs Délas*. Brine was used as the circulating medium.

While bracket fans and electric punkahs were frequently provided to obtain the cooling effect associated with air motion, it appears that up to 1924 no effort was made to introduce the ventilation air into the space to accomplish the same result. Punkah louvers were introduced first about 1925 on the *T.S.S. Caledonia* and this device is still common today and consists of a ball and socket arrangement which permits directing the supply air (at very high velocity) to any desired location.

An article published in 1926 stressed the importance of humidity in cargo hold spaces. The idea was apparently new as the paper discussed both the development of means for controlling and measuring the humidity. The importance of eliminating carbon dioxide when carrying apples was also emphasized. Since 1926 considerable research has taken place, and operators now realize that ventilation must be controlled to suit the relation between humidity in the outside air and hold. The *S.S. Exporter* (1938) was the first vessel to be fitted with a dehumidifying system for eliminating condensation and allied damage to cargo.

The *Queen of Bermuda* and *Monarch of Bermuda* (1928) were probably the first vessels to use the modern axial flow fan, which has since largely supplanted centrifugal fans in both naval and merchant vessels.

The advent of motor vessels increased the problem of ventilating engine rooms. Reports indicate that very unhealthy conditions existed in these spaces due to the leakage of exhaust gases and the vaporization of lubricating oil. It is interesting to note that the introduction of this type of propulsion also accelerated the scientific investigation of noise prevention and insulation on ships. An article written by G. Robinson in 1931 discussed the theory of sound control and specifically mentions that the *M/V Britannic* had sound insulation on the engine casing and on the deck over the machinery space. This paper also mentions that sound insulation was provided for cabins on the *M/V Ulster Queen.*

The *S.S. Mariposa* (1931) was the first American ship and the second ship in the world equipped with modern air conditioning.

The *Normandie* (1935) was the first ship on which all heating and ventilating equipment was housed inside deck houses or the main structure. This arrangement greatly improved the vessel's appearance because the profile was not distorted by ugly cowls, mushrooms and similar appurtenances. This practice had the additional advantage of providing greater unobstructed deck space, and also of simplifying and protecting the ventilating equipment. The *Normandie* was possibly the first vessel equipped with sound-proofed fan rooms. In addition, it was the first vessel to have central control of fans for fire protection.

The *Queen Mary* (1936) was exceptional in several ways. Diffusers were used for distributing the air in the engine room. In addition to soundproofing of fan rooms, fans and motors were placed on cork anti-vibration mountings. While staterooms were fitted with punkah louvers, ceiling diffusers were used for distributing the air supplied to public spaces. Five air conditioning systems served the cabin class restaurant and lounge, tourist class dining room, and hairdressing rooms. Automatic (pneumatic) temperature, humidity, and damper controls were provided for these systems. A steam jet refrigeration system, said to be the first to be installed on board ship, was used with most of the air conditioning systems. Like many other large passenger ships built at this time, electric convectors with double casings were provided for heating the better class staterooms and suites.

The *Queen Elizabeth* (1938) had considerably more air conditioning than any ship previously built and the steam jet refrigeration system was the largest of its kind.

The extent to which air conditioning will be adopted in the future is indicated by the design of numerous vessels, the construction of which was curtailed by the present emergency. Four vessels were designed for the Moore & McCormack S.S. Co. in 1939 which were equipped with air conditioning in all public spaces and staterooms. These vessels were partially completed before they were assigned. Separate air conditioning units were provided for each stateroom consisting of filters, heat transfer coils, blowers, casings, and thermostatic controls. Preheated air was supplied to these units during the heating cycle and "Freon 12" was used as the refrigerant for precooling purpose. Hot or cold water was supplied to the heat transfer coils of the stateroom units.

In 1940 three vessels designed for the Alcoa S. S. Co. were provided with a new method for heating and ventilating the passenger staterooms. Filtered and preheated air was supplied to thermostatically controlled room booster heaters. Heat was supplied to the booster heaters by means of a one-pipe forced hot water system constructed of copper pipe and special flow fittings. Wall registers were used to introduce the air to the treated space. Recirculation of 50 per cent of the air handled was also provided. The above design was advantageous in that summer cooling could easily be added at any time without making major alterations in the original system.

The foregoing history relates the progress made in 50 years of development in the art of ventilating, heating and air conditioning ships. It is evident, however, that the methods of ventilating and heating most common today are basically the same as those used many years ago. The progress, therefore, consists chiefly in the greater application of comfort systems, and the perfection of details and equipment which improve economy of design and operation, as well as closer control of conditions.

Progress continues and while we may not be able to predict the type of system which will be in use after another 50 years, the following predictions may be made:

1. Greater strides will be made in the next 50 years because of the great progress being made in comfort and industrial conditioning research.
2. Ships must compete with other forms of faster transportation, by providing better comfort conditions and delivering cargoes in better condition.
3. The traveling public is *air condition conscious* and demands comfortable accommodations all year round in all climates. No American built vessel will be constructed without extensive *air conditioning* for public passenger spaces and staterooms. Also, many vessels will have *air conditioned* crews' accommodations.

NOMINATIONS FOR 1945

Nominations for Officers and Council

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1945, submits the following list of nominees:

For President:
C.-E. A. WINSLOW, New Haven, Conn.

For First Vice-President:
ALFRED J. OFFNER, New York, N. Y.

For Second Vice-President:
W. A. RUSSELL, Kansas City, Mo.

For Treasurer:
L. P. SAUNDERS, Lockport, N. Y.

For Members of Council (Three-Year Term)
W. A. DANIELSON, Memphis, Tenn.
H. R. ROTH, Toronto, Ont., Canada
ERNEST SZEKELY, Milwaukee, Wis.
B. M. WOODS, Berkeley, Calif.

Respectfully submitted,
NOMINATING COMMITTEE,
E. M. MITTENDORFF, *Chairman*

In accordance with the provisions of the Society's Constitution, By-Laws and Rules, ballots containing the names of the above candidates will be sent to the membership for voting upon prior to the Annual Meeting in January.

Art. B-VIII—*Section 11.* The Nominating Committee shall consist of one (1) member eligible to vote designated by each Chapter, or his alternate also appointed by the Chapter. The Secretary of each Chapter shall certify to the Secretary of the Society on or before January first the names of the member and alternate selected.

The Committee shall meet at the Annual Meeting of the Society at the call of the Secretary of the Society and shall effect its own organization and elect its own Chairman. At the Semi-Annual Meeting of the Society, if possible, the Nominating Committee shall select the nominees for the ensuing year for the offices of President, First Vice-President, Second Vice-President, Treasurer, and four (4) members of the Council. In any event the names of the nominees shall be certified to the Secretary of the Society before September twentieth, with the written consent of each nominee to fill the office for which he has been selected and their names with the offices to which they have been nominated shall be published in the October issue of the Journal

Art. B-1X—*Section 1.* Twenty (20) or more members of the Society, eligible to vote, may present to the Secretary, over their signatures, the name of any member eligible to hold office in the Society as a candidate for any office, provided such name is presented at least sixty (60) days preceding the next Annual Meeting, together with the written consent of the nominee to fill the office for which he has been selected, and the Secretary shall add such names to the ballot if they are not already included in the list of names presented in the formal report of the Nominating Committee. Such names when presented shall be included on the printed ballot, with special notation that they are presented by members independent of the Nominating Committee report . . . .

Art. B-1X—*Section 2.* The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election.* The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1945.

Three-Year Term

R. M. CONNER, Cleveland, Ohio

JOHN A. GOFF, Philadelphia, Pa.

F. W. HUTCHINSON, Berkeley, Calif.

R. K. THULMAN, Washington, D. C.

W. F. ZIEBER, York, Pa.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

ARTICLE II—ORGANIZATION

Section 1. Committee on Research—There shall be a standing committee known as the Committee on Research, consisting of fifteen (15) members each serving for three (3) years and five (5) retiring each year. The outgoing Chairman if serving in that capacity during the last year of his three (3) year term on the Committee shall without election become an additional member of the Committee on Research for one (1) year.

(*a*) The Council shall nominate previous to July first of each year five (5) members to fill the vacancies of those retiring at the next Annual Meeting.

(*b*) The nominations made by the Council shall be published in the October issue of the Society's Journal.

(*c*) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(*d*) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-Laws and Rules.

(*e*) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

1945 Nominees for Council

(Three-Year Term)

W. A. Danielson, Brigadier General, U. S. A., Memphis, Tenn., was born July 25, 1884, at Des Moines, Ia. He received his B. S. in electrical engineering from Iowa State College, Ames, Ia., in 1907, and in 1926 he received the degree of M. S. from the Massachusetts Institute of Technology after a year of special work.

W. A. Danielson
Memphis, Tenn.

Following his graduation from Iowa State he spent one year with the General Electric Co., Schenectady, N. Y., and then took the necessary examination and was commissioned in the Coast Artillery Corps of the United States Army. He resigned from the Army in 1913 and was re-commissioned in 1916. In 1917 he was transferred to the Field Artillery and served with that branch during World War I. Upon his return from France in 1919 he was assigned to construction work in the Philippine Islands, which work included the building of two air stations and a number of other isolated buildings in addition to the regular maintenance and operation of all Army stations and utilities in the Islands. Returning from the Philippines in 1921 he was assigned to the Quartermaster General's office in charge of maintenance and operation of all Army stations. He continued on this work until 1932, except for one year spent at M. I. T. In 1932 he was assigned to new construction work and has been on that work either in the Quartermaster General's office or in the field to date. In 1933 he was placed in charge of the New Construction Branch of the Quartermaster General's office, and his work included the designing and contracting for about $50,000,000 of buildings and utilities.

The first heating work in which General Danielson was engaged was the installation of a hot-water gravity system in a greenhouse. He was not only the designing engineer on this job but also wielded the tools that installed the piping and boiler. As quartermaster at a large Army station he had charge of the operation of a large number of heating plants and a steam power station, together with a number of small steamers.

When he left the Army in 1913 he became assistant general manager and electrical engineer for a power system in the Northwest, in charge of the construction of something over 100 miles of transmission lines, sub-stations, etc., from 66,000 volts down.

His work since the World War I has had to do with all phases of engineering and construction. Heating, and lately ventilating and air conditioning, have become such important elements in both construction and operation that a great deal of his time and attention has been devoted to these subjects.

General Danielson has had the opportunity of contacting engineers in every line of endeavor and he brings to the Society a viewpoint that includes not only heating, but also an intimate knowledge of all other construction details.

He became a member of the Society in 1935 and was elected Chairman of the Committee on Research of the Society in 1936 and 1937. Besides being a member of the Society, General Danielson is also a member of the *American Institute of Electrical Engineers*, the *Society of American Military Engineers*, the Army and Navy Country Club and the Cosmos Club of Washington, D. C., and the Army and Navy Club of Manila, P. I.

Harold R. Roth, Toronto, Ont., Canada, was born at Rensselaer, Ind., December 6, 1904. He was graduated from the Rensselaer High School, and from Purdue University with a B. S. in mechanical engineering in 1926.

His first assignment was with the American Blower Corp., Detroit, Mich., as student engineer, and after a short time he became sales engineer. In 1928 he became sales engineer with McKellar and Blackhall, Canadian Sirocco Co., Ltd., agents. He has had an extensive experience in design work, and since 1930 he has been responsible for the heating system of the Aluminum Company of Canada, for a vapor absorption layout for the Ontario Paper Co. at Thorold, Ontario, and for the heating layout of the Canada Wire and Cable

H. R. Roth
Toronto, Canada

Plant at Montreal. Some of his work in other fields included a dust collecting system for the City of Toronto Asphalt Plant, the ventilating system for the Kirkland Lake, Ontario, theater, and the heating and ventilating system for the Eldorado Gold Mines' laboratory at Port Hope, Ontario, where radium is manufactured.

Mr. Roth has served as the Ontario Chapter's delegate for many years, and as its secretary since 1930, and served as a member of the Society's Nominating Committee in 1938, 1939 and 1940.

He is also a member of the Board of Trade of the City of Toronto, the Professional Engineers in the Province of Ontario, and

the Pi Tau Sigma and Sigma Phi Epsilon.

Ernest Szekely, president, Bayley Blower Co., Milwaukee, Wis., was born July 24, 1888, at Debrecen, Hungary. He was graduated in 1910 from the University of Budapest with an M. E. degree.

Ernest Szekely
Milwaukee, Wis.

Following his graduation he spent two years at the University as assistant professor of thermodynamics, heating and ventilating, and in 1912 he became associated with Jeffrey Mfg. Co. and Guarantee Construction Co., New York, where he designed elevating systems and did general engineering work. In 1914 he joined the staff of the American Blower Co. at Detroit, as research engineer in heating and ventilating.

Mr. Szekely joined the Society in 1920 and has been active in both the Northern Ohio and Wisconsin Chapters. He served the Northern Ohio Chapter as its vice-president and president in 1923 and 1924 and the Wisconsin Chapter as second vice-president, vice-president and president in 1933, 1934, and 1935, consecutively, and as a member of its Board of Governors from 1936-1938. Mr. Szekely also served on many code and other committees of the Wisconsin Chapter.

He has also served on many Society committees, such as, Code for Exhaust Systems, Committee on Subjects, Infiltration in Buildings, Nominating Committee, Effect of Entering Temperature and Velocity on the Temperature and Distribution of Air Within an Enclosure, serving as its chairman in 1936, and as chairman of the Committee on Air Distribution in 1937. He was also a member of the Fan Test Code Committee and the Committee on Air Distribution and Air Friction.

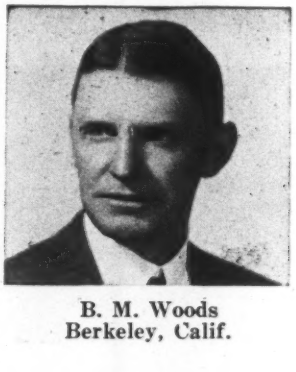
Mr. Szekely has published engineering articles in the technical field and is among those listed in Who's Who in Engineering. He is a member of the Rotary Club.

Dr. Baldwin M. Woods, professor of mechanical engineering at the University of California, was born at Lampassas, Texas, on September 22, 1887. He has been associated with the University for over 35 years, beginning as a student assistant in engineering in the fall of 1908, after receiving the degree of Electrical Engineer from the University of Texas. In 1909 he received his M. S. degree in electrical engineering, and in 1912 his Ph. D., both from the University of California. He also studied at the University of Paris and the University of Munchen.

Dr. Woods was appointed University Examiner in 1916, which was a new office created in recognition of the growth of the junior colleges. From 1921-23 he was director of the summer session at the University of California at Los Angeles, and the two following years he was Assistant Dean of the University. From 1924-1930 he was Associate Dean and Representative in Educational Relations, and in 1930 was given the title of Professor of Mechanical Engineering and was appointed to the Chairmanship of the Department. He was appointed Director of University Extension in August 1942.

In 1936 Dr. Woods took a year's leave from the University to accept appointment in Washington, D. C., with the National Resources Committee as Consultant in a Survey of Federal Research in the United States. Returning to the University, he maintained relations with the National Resources Planning Board, as chairman of Region 8, which incorporated the states of California, Arizona, Nevada and Utah, until it was dissolved by an Act of Congress on June 30, 1943.

Dr. Woods joined the Society in 1937 and has served on numerous Society committees. Among these are the Committee on Research, Committee on Engineering in its Relation to Public Health, Technical Advisory Committee on Cooling Towers, Evaporative Condensers and Spray Ponds, the Nominating Committee, Committee on Engineering Scholarships, Advisory Committee for Pacific Heating and Air Conditioning Exposition, War Service Committee as its chairman,



B. M. Woods
Berkeley, Calif.

and a member of the Society's Council and as chairman of its Finance Committee.

Dr. Woods, in collaboration with colleagues, has written a book on engineering economy, one on the dynamics of airplanes, extensive tables of hyperbolic functions, and a booklet on air conditioning. He has contributed many miscellaneous technical and nontechnical articles to various publications, as well as many articles for the Society.

He is also a fellow in the *American Association for the Advancement of Science*, a member of the *ASME*, the *Society for the Promotion of Engineering Education*, *U. S. Naval Institute*, *Air Conditioning Society of San Francisco* (Honorary), *Institute of the Aeronautical Sciences* (Founder Member), *American Society of Planning Officials*, *Pacific Coast Gas Association*, *Newcomen Society of England*, as well as a member of the Tau Beta Pi, Eta Kappa Nu, and Phi Delta Kappa fraternities. Dr. Woods belongs to the Diable Country Club, Faculty and Engineers Clubs, Commonwealth Club of California, and the 100,000 Mile Club (United Air Lines), and is listed in Who's Who in Engineering.

Society's 51st Annual Meeting in Boston

THE 51ST Annual Meeting of the Society will be held at the Hotel Statler, Boston, January 22-24, 1945, with Massachusetts Chapter serving as hosts.

General Chairman Earl G. Carrier had an organization meeting of the Committee on Arrangements at the Engineers' Club on October 2, and the program for the meeting was planned. He announced the personnel of committees to handle the details of the meeting.

The Meetings Committee is working on plans for the technical sessions and complete details will be ready for announcement after approval by Council at its October 16 meeting. Look for further details in the November issue.

Earl G. Carrier
Boston, Mass.

Committee on Arrangements
Earl G. Carrier, *General Chairman*
Vice-Chairmen
James Holt and David Archer
W. T. Jones, *Advisory Chairman*

Banquet . . . . . G. B. Gerrish
Finance . . . . . J. W. Brinton
Transportation . . . . . F. R. Ellis
Publicity . . . . . A. C. Bartlett
Entertainment . . . . . C. M. F. Peterson
Ladies . . . . . A. L. Hesselschwerdt, Jr.
Reception and Registration . . . . . P. A. Croney

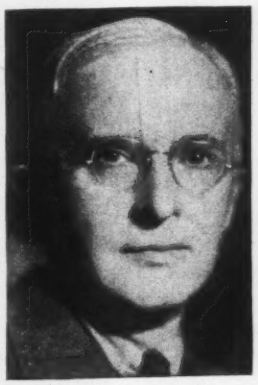
Research Fund Campaign

Announcement has been made by Prof. G. L. Tuve, Chairman of the Committee on Research, that Samuel R. Lewis, Chicago, consulting engineer, will serve as Chairman of the Research Finance Committee in an active campaign that will be undertaken at once for support of the new research program.

A new booklet of 32 pages fully describes 28 Research Projects of importance to the profession and the industry that have been approved by the Committee on Research. Each project is treated on a single page with a brief statement of the purpose for quick reference, and a more detailed outline of the technical plan which covers specific objectives, type of research and the general method of procedure.

The pamphlet contains a description of the new Research Laboratory at Cleveland, a list of all Committee personnel, and a center spread lists the Planned Research Projects and Research in Progress. A copy of the pamphlet is being mailed to each member of the Society and it will provide a graphic means of visualizing the extent of the current Research Program.

G. L. Tuve
Cleveland, Ohio



S. R. Lewis
Chicago, Ill.

The dues of every member and associate member support the Research work of the Society, and in addition contributions and agreements for cooperative research permit a greatly expanded program of investigation of fundamental problems.

Little did the founders of the Society and those who pioneered the establishment of the Research Laboratory of the Society realize the scope of its work in research. For 25 years the research of the Society has provided a glimpse into the future of Heating, Ventilating and Air Conditioning. It is of vital importance to the profession and industry to have this work continue and to provide the necessary funds to carry it on effectively.

E. T. Selig

E. T. SELIG, JR., JOINS RYBOLT HEATER CO.

The Rybolt Heater Co. of Ashland, Ohio, has announced the appointment of E. T. Selig, Jr., as Director of Engineering as of September 1.

A graduate of Dartmouth College, Mr. Selig's most recent connection was with the construction of the Geneva Steel Works at Geneva, Utah. Prior to this project he was chief mechanical engineer for the construction of Camp Hale, Colo., the training center for ski and mountain troops of the United States Army. Previously, Mr. Selig was chief research engineer for Campbell Taggart Research Corp., Kansas City, Mo., and earlier in his career he was an industrial fellow on the Anthracite Industries Fellowship at Mellon Institute of Industrial Research, Pittsburgh. Following graduation, Mr. Selig was mechanical engineer and treasurer of Fuel Savers, Inc., Harrisburg, Pa. He has been granted several patents relating to combustion control systems by the United States and Canada.

Mr. Selig has been a member of the ASHVE since 1936 and by his training and experience he is well qualified for his new position with The Rybolt Heater Co.

W. A. MINKLER RECEIVES NEW APPOINTMENT

The appointment of William A. Minkler as application manager for air conditioning of the Westinghouse Electric Elevator Co., Jersey City, N. J., has been announced by the company's manager in Pittsburgh.

Mr. Minkler, born in Chicago, was graduated from the California Institute of Technology in 1927, and that same year entered the employ of Westinghouse in the East Pittsburgh, Pa., Works. In 1931 he became active in the production of air conditioning apparatus, and from 1941 to 1944 he was air conditioning sales manager of the Young Radiator Co., returning to Westinghouse this year.

Mr. Minkler became a member of the Society in 1940 and has taken an active interest in its activities, as well as in its local affiliations.

PREDICTS MORE ELECTRIC HEATING

Bert W. Farnes of Bert W. Farnes Co., Portland, Ore., has spent the past few months in the Eastern states. In commenting on the fuel shortage problems, it was his opinion that wood and sawdust will practically be eliminated as a home fuel in Oregon, due to the development of processes for reducing the amount of waste fuel produced at the mills and the use of sawdust to produce other products. He also spoke of the progress being made in expanding electric heating and cooking systems in the Northwest, and the recent development of an electric heat storage system for homes to use the available off-peak load.

A. A. KUCHER VICE PRESIDENT OF BENDIX

A. A. Kucher, director of research of Bendix Aviation Corp., Detroit, Mich., and chairman of its long range planning committee, has been elected a vice-president, according to a recent announcement by the president.

Mr. Kucher is head of the corporation's central research laboratories in Detroit and has charge of investigating and developing new product activities, and new business opportunities for Bendix through the long-range planning committee's work. The job of evaluating new technical resources and analyzing opportunities for the company's use has been going forward rapidly under Mr. Kucher's direction, according to the announcement.

Mr. Kucher was born in Jersey City, N. J., where he received his early education. During World War I he was associated with several eastern aircraft manufacturers in their engineering departments, and organized and taught a course in aerodynamics at the City College of New York. From 1921-1927 he was consulting engineer on domestic electrical refrigeration for Westinghouse Electric and Manufacturing Co., and from 1928-1931 he headed his own laboratory and engineering organization in New York.

A. A. Kucher

In 1931 he joined General Motors Corp., as manager of household refrigeration engineering and later manager of research engineering for the Frigidaire Division at Dayton, Ohio. In 1942 he left General Motors to become head of the central research laboratories of Bendix Aviation Corp. He became a member of the Society in 1938.

C. N. PALMER DIES IN TORONTO

Cecil Norris Palmer, for many years manager of the Stoker Division, Pease Foundry, Ltd., Toronto, Ont., Canada, died on August 18, 1944, after putting up a valiant fight since the first of the year.

Mr. Palmer was born in Maitland, Ont., on June 1, 1891, and was graduated from the Brockville Collegiate Institute, Brockville, Ont., in 1909. A large part of his life has been devoted to the stoker industry, and prior to his employment by the Pease Foundry he was sales and service manager for both the Peppers Automatic Stokers, Ltd., which he held for six years, and the Ritson Automatic Stoker Co., which covered a period of two years.

Mr. Palmer was a devoted family man and very active in church activities. He was the superintendent of Sunday School for the past ten years at the People's Church in Toronto, and was one of the Elders.

He is survived by his wife and daughter, Dorothy, to whom the Officers and Council of the Society extend their sincere and heartfelt sympathy.

SUMMARY OF LOCAL CHAPTER MEETINGS

Chapter	Meeting Date	Subject	Speakers	Other Features	Attendance	Attendance Ratio*
Atlanta	Sept. 11	The Engineer in the Post War World	C.-E. A. Winslow, 1st Vice-Pres. of ASHVE, New Haven, Conn.	C. L. Templin, chairman of Membership Committee reported on membership	23	0.48
Iowa	May 9	Resume of State Ventilation Code	M. L. Todd, chairman Legislative Investigating Committee	L. E. Hedeen reported on State School Code Election of Officers	19	0.76
North Texas	Aug. 21	Electronics (Walt Disney sound films)	J. P. Ashcraft, Minneapolis-Honeywell Regulator Co.	Pres. McClanahan announced plans for September meeting	38	0.80
South Texas	Aug. 11	Post War Planning and Present Trends	J. J. Felsecker, Sales Mgr., Graver Tank Mfg. Co., Inc., E. Chicago, Ind.	D. M. Mills, chairman of Program Committee, announced schedule	23	1.
Southern California	Sept. 11	The Air Conditioning of Green Houses	A. J. Hess, Engr., English & Lauer, Inc., Los Angeles, Calif.		68	0.90
Wisconsin	Sept. 18	Packaged Heat—Its Present Applications and Post War Possibilities	D. J. Jones, Vapor Car Heating Co., Chicago	J. R. Vernon, chairman Program Committee, outlined schedule	51	0.85

*The attendance ratios shown represent the meeting attendance divided by the Chapter membership. These will be useful as a partial indication of interest shown by local chapter members in various types of subjects programmed by other local chapters and may be helpful in deciding on subjects for other chapter meetings.

Candidates for Membership

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the Journal of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 26 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by October 16, 1944, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

Candidates	References	
	Proposers	*Seconders*
Baxter, Arthur G., Htg. Engr., The Enterprise Foundry Co., Ltd., Amherst, Nova Scotia.	C. F. Johns F. R. Rand	Bernard Stotesbury F. R. Bishop
Beery, Vernon L., Mech. Engr., Post Engineer, Smoky Hill Army Airfield, Salina, Kans.	W. F. Ryan I. E. Brooke	D. M. Allen A. O. May
Boehler, Carl L., Sales Mgr., J. A. Walsh & Co., Inc., Houston, Tex.	J. A. Walsh F. C. Brandt	A. J. Rummel D. M. Mills
Brackmann, Walter H., Fuel Engr., Kansas City Coal Service Institute, Kansas City, Mo.	R. B. Mason D. M. Allen	W. A. Russell Gustav Nottberg
Bull, Harold A., Sales Engr., Kruse Engineering Co., Newark, N. J.	W. C. Kruse, Jr. Joe Wheeler, Jr.	M. F. Rather J. G. Skidmore
Callaway, James H., Mech. Equip. Engr., Bell Aircraft Corp., Atlanta, Ga.	T. T. Tucker L. L. Barnes	C. L. Templin I. B. Kagey
Carsey, E. A., Engr., The Kirk & Blum Manufacturing Co., Cincinnati, Ohio.	I. B. Helburn R. W. Sigmund	C. E. Brown T. D. Boyd
Fyfe, John H., Chief Engr., Automatic Coal Burner Co., Philadelphia, Pa.	H. T. Makin, Jr. M. F. Blankin	H. H. Erickson C. F. Dietz
Hagen, George M., Vice-Pres., Hagen & Co., Halifax Ltd., Halifax, Nova Scotia.	T. H. Worthington F. A. Hamlet	Leo Garneau J. B. Dykes
Hemeon, Wesley C. L., Vent. Engr., Industrial Hygiene Foundation, Pittsburgh, Pa.	R. H. Heilman Philip Drinker	C. P. Yaglou F. R. Ellis
Hunzicker, Dean L., Engr., Research Products Corp., Madison, Wis.	G. L. Larson D. W. Nelson	*B. G. Elliott *L. A. Wilson

*Non-Member.

LAINSON, HARRY A., JR., Secy.-Treas., Jaden Manufacturing Co., Hastings, Nebr.	*H. A. Lainson *B. T. Oberg	*A. J. Koelling *F. E. Weyer
LOVELAND, FRANCIS P., Denver, Colo.	J. M. Curtice G. D. Maves	E. J. McEahern F. L. Adams
MAURER, ELMER E., Secy. & Engr., The Maurer Bros. Co., Cleveland, Ohio.	R. H. Cutting J. E. Wilhelm	D. L. Taze R. T. Southmayd
MCLANE, E. H., Regional Comm'l. Supvsr., York Corp., Houston, Tex.	J. C. Lewis J. A. Walsh	F. C. Brandt B. P. Fisher
MONAHAN, MAURICE B., Mfr's. Agent, Montreal, Que., Canada.	A. B. Madden Leo Garneau	F. A. Hamlet F. G. Phipps
MURRAY, G. F. J., Tech. Mgr., British Doby Stokers Ltd., London, W. 1, England.	J. R. Kell G. J. Happerfield	Walter Yates H. E. Bartley
PATTERSON, JOSEPH C., JR., Marine Engr., La-Del Conveyor & Manufacturing Co., Washington, D. C.	E. R. Queer John Everetts, Jr.	J. G. Muirheid C. M. Hamblin
RAMSEY, ERNEST C., Htg. Engr., The Ohio Fuel Gas Co., Columbus, Ohio.	W. M. Myler, Jr. J. D. Slemmons	A. W. Williams Howard Allonier
RUBIN, LOUIS, Owner, L. Rubin Co., Detroit, Mich.	F. A. Lindsley James Beattie	W. G. Boales F. X. Marzolf
SEDGWICK, STANLEY W., Dist. Mgr., Trane Company of Canada, Ltd., Toronto, Ont., Canada.	S. D. Jenkins V. J. Jenkinson	*T. C. Agnew W. H. Evans
SLATER, WILLIAM F., Pres., W. F. Slater Engineering Corp., Memphis, Tenn.	J. D. Flinn T. J. O'Brien	W. L. Welliford, Jr. W. E. Thorpe
SMITH, OLIVER F., JR., Project Engr., Armstrong Cork Co., Lancaster, Pa.	E. C. Lloyd F. D. Close	*C. F. Hawker *William Noyes
SUMMERVILLE, E. A., Des Moines, Iowa.	Perry LaRue F. E. Triggs	C. H. McGuiness W. W. Stuart
TELGEMEIER, A. H., Vice-Pres., Southern Oil Co., Kansas City, Mo.	W. A. Russell Gustav Nottberg	R. B. Mason J. G. Lewis
THOM, HERBERT C. S., Chief, Statistics Div., U. S. Weather Bureau, Washington, D. C.	J. F. Collins, Jr. C. M. Humphreys	Raymond Little H. F. Hebley

Candidates Elected

In the past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

BELDEN, A. G., JR., Pres., Refrigeration & Appliance Service, Inc., Terre Haute, Ind.

BERRY, N. E., Director of Research, Servel Inc., Evansville, Ind.

BRYCE, JOHN H., Supervising Engr., Kaighin & Hughes, Toledo, Ohio.

BURNS, ROBERT, Yonkers, N. Y. (*Reinstatement*)

CRARY, JAMES O., Administrative Mgr., Higgins Industries, Inc., New Orleans, La. (*Reinstatement & Advancement*)

CRIQUI, ALBERT E., Mech. Engr., Buffalo Forge Co., Buffalo, N. Y.

DARBY, THOMAS E., Gen. Service Mgr., The Ohio Fuel Gas Co., Columbus, Ohio.

DAWSON, FRED C., Engr., B. F. Sturtevant Co., Boston, Mass.

FORSYTH, STUART L., Advisory Engr., Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.

GLANZER, CLARENCE J., Chief Engr., Air-Maze Corp., Northfield, Ohio.

GROSS, MORRIS H., Co-Owner, L. Rubin Co., Detroit, Mich.

HUGHES, RALPH, Partner, Hughes Heating Co., Memphis, Tenn. (*Advancement*)

JANITZ, ROBERT H., Co-Partner, Fred G. & Robert H. Janitz, Indianapolis, Ind.

JENNINGS, JAMES H., Htg. & Vent. Engr., General Electric Co., Fort Wayne, Ind.

KUTTLER, JOHN B., Asst. Chief Engr., Prudential Insurance Co. of America, Newark, N. J.

LOCKHART, HAROLD A., Chief Engr., Bell & Gossett Co., Morton Grove, Ill. (*Advancement*)

MACFERRIN, JOHN B., Htg. & Vent. Engr., Pittsburg Water Heater Sales Co., Houston, Tex.

ROSS, EARL F., Mech. Engr., W. C. Kruger, Architect & Associates, Santa Fe, New Mexico.

RUFF, A. W., Vice-Pres., York-Shipley, Inc., York, Pa.

SCHMIDT, CARL W., Dist. Indus. Mgr., B. F. Sturtevant Co., Camden, N. J.

SHAW, GEORGE W. D., Supt. & Engr., Lorne Plumbing & Heating Co., Detroit, Mich.

SKIDMORE, JOHN G., Alnirall & Co., Inc., New York, N. Y. (*Advancement*)

SPURLOCK, BENJAMIN H., JR., Asst. Prof. of Mech. Engrg., University of Colorado, Boulder, Colo.

VAMOS, GEORGE, Engr., A. & T. Burt Ltd., Wellington, New Zealand

WALKER, T. R., Vice-Pres., Columbus Heating & Ventilating Co., Columbus, Ohio.

WARD, BENJAMIN G., Mech. Engr., U. S. Engineers, District Office, Denver, Colo.

WINDSOR, WILLIAM G., Elec. Engr., South African Railways, Airways & Harbors Administration, Johannesburg, Transvaal, South Africa.

ASSOCIATES

BEVIL, A. T., Engr., W. F. Slater Engineering Corp., Memphis, Tenn. (*Reinstatement*)

BLEIER, FRANK P., Research & Development Engr., Ilg Electric Ventilating Co., Chicago, Ill.

BROWN, WARD A., Assoc. Engr., George Wagschal Associates, Detroit, Mich.

CARDER, WILLIAM W., Mgr., Johnson Service Co., Atlanta, Ga. (*Reinstatement*)

CARTER, HENRY G., Mfrs'. Agent, Tampa, Fla.

DAVIDSON, JAMES W., Pres., Davidson Heating Co., Val Morin, Que., Canada.

ENGLEHART, O. D., Research Engr., Pittsburgh Plate Glass Co., Creighton, Pa.

EVANS, D. C., Chief Engr., I. Magnin & Co., Los Angeles, Calif.

GOTTSCHALK, KENNETH A., Indus. Power Engr., Cleveland Electric Illuminating Co., Cleveland, Ohio.

HOUSEHOLDER, H. L., Mgr. & Owner, Householder Heating Corp., Buffalo, N. Y.

KAUN, WILLIAM F., Partner, W. F. Kaun & Son, Dallas, Tex.

KEMP, WILLIAM H., Shipbuilding Div., Bureau of Ships, U. S. Navy, Washington, D. C.

KITTLESON, HOWARD B., Supt. of Maint., Kraft Cheese Co., Albany, Minn.

LASLEY, JAMES B., Asst. Foreman, Plant Engineer's Dept., North Carolina Shipbuilding Co., Wilmington, N. C.

MCFADDEN, H. J., Sales Engr., Servel Inc., Dallas, Tex.

MUSE, M. H., Mgr., Southern Welding Co., Johnson City, Tenn.

OLSON, NAT I., United Blower Co., Inc., New York, N. Y.

POLLOCK, C. W., Research Engr., Drayer and Hanson, Inc., Los Angeles, Calif.

REES, HAROLD R., Owner, Rees Plumbing & Heating Co., Jonesboro, Ark.

SACK, HERMAN S., Archt. & Engr., Waldorf System, Inc., Boston, Mass.

VISINTINE, EDWARD C., Owner & Mgr., Madison Plumbing & Heating Co., London, Ohio.

WALZ, GEORGE R., Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. (*Reinstatement*)

WIBALDA, R. K., Asst. to Secy., J. J. Howden Co., Muskegon, Mich.

WILLIAMS, KENNETH O., Asst. Mgr., N. O. Nelson Co., St. Louis, Mo.

WOLFE, CLARENCE E., SR., Chief Supt., Reynolds Corp., Chicago, Ill.

WOODBRIDGE, WILLIAM L., Owner & Operator, Woodbridge Plumbing & Heating, Milford, Mich.

Officers

President.....S. H. Downs
First Vice-President.....C.-E. A. Winslow
Second Vice-President.....Alfred J. Offner
Treasurer.....L. P. Saunders
Secretary.....A. V. Hutchinson
Technical Secretary.....Carl H. Flink

Council

S. H. Downs, *Chairman* C.-E. A. Winslow, *Vice-Chairman*

Three Years: C. M. Ashley, L. T. Avery, L. E. Seeley, G. D. Winans.

Two Years: J. F. Collins, Jr., James Holt, E. N. McDonnell, T. H. Urdahl.

One Year: W. A. Danielson, L. G. Miller, A. E. Stacey, Jr., B. M. Woods, M. F. Blankin, G. L. Tuve. *Ex-Officio.*

Council Committees

Executive—A. J. Offner, *Chairman;* E. N. McDonnell, A. E. Stacey, Jr.

Finance—B. M. Woods, *Chairman;* L. E. Seeley, T. H. Urdahl, L. P. Saunders, *Ex-Officio.*

Membership—M. F. Blankin, *Chairman;* J. F. Collins, Jr., G. D. Winans.

Meetings—C.-E. A. Winslow, *Chairman;* L. T. Avery, L. G. Miller.

Standards—L. P. Saunders, *Chairman;* C. M. Ashley, James Holt.

Advisory Council

M. F. Blankin, *Chairman;* Homer Addams, D. S. Boyden, W. H. Carrier, S. E. Dibble, W. H. Driscoll, E. O. Eastwood, W. L. Fleisher, H. P. Gant, F. E. Giesecke, E. Holt Gurney, L. A. Harding, H. M. Hart, C. V. Haynes, E. Vernon Hill, John Howatt, W. T. Jones, D. D. Kimball, G. L. Larson, S. R. Lewis, Thornton Lewis, J. F. McIntire, F. B. Rowley and A. C. Willard.

Nominating Committee

Chapter	Representative	Alternate
Atlanta	T. T. Tucker	I. B. Kagey
Cincinnati	G. V. Sutfin	H. A. Pillen
Connecticut	H. E. Adams	Stanley Hart
Delta	J. S. Burke	C. B. Gamble
Golden Gate	R. A. Folsom	C. E. Bentley
Illinois	E. M. Mittendorff	A. O. May
Indiana	G. B. Supple	J. G. Hayes
Iowa	C. W. Helstrom	W. W. Stuart
Kansas City	D. M. Allen	W. A. Russell
Manitoba	F. L. Chester	William Glass
Massachusetts	E. G. Carrier	R. T. Kern
Michigan	S. S. Sanford	W. H. Old
Minnesota	R. C. Jordan	F. B. Rowley
Montreal	T. H. Worthington	A. B. Madden
Nebraska	D. E. McCulley	B. G. Peterson
New York	R. A. Wasson	C. S. Koehler
North Carolina	Arvin Page	P. L. Guest, Jr.
North Texas	G. A. Linskie	E. T. Gessell
Northern Ohio	L. S. Ries	John James
Oklahoma	E. T. P. Ellingson	
Ontario	V. J. Jenkinson	W. C. Kelly
Oregon	E. C. Willey	
Pacific Northwest	M. N. Musgrave	J. D. Sparks
Philadelphia	H. B. Hedges	Edwin Elliot
Pittsburgh	T. F. Rockwell	E. H. Riesmeyer, Jr.
St. Louis	G. B. Rodenheiser	C. F. Boester
South Texas	J. A. Walsh	A. B. Banowsky
Southern California	Leo Hungerford	W. O. Stewart
Washington, D. C.	F. A. Leser	W. H. Littleford
Western Michigan	C. H. Pesterfield	J. W. Miller
Western New York	S. M. Quackenbush	S. W. Strouse
Wisconsin	A. S. Krenz	M. W. Bishop

Officers of Local Chapters

Atlanta: Organized, 1937. Headquarters, Atlanta, Ga. Meets, First Monday. President, M. M. Crout, 412 Houston St., N. E. Secretary, L. L. Barnes, 3995 N. Stratford Rd.

Central Ohio: Organized, 1944. Headquarters, Columbus, Ohio. President, J. D. Slemmons, 2 Fifteenth Ave., Columbus 1. Secretary, A. W. Williams, 5 E. Long St., Room 808, Columbus 15.

Cincinnati: Organized, 1932. Headquarters, Cincinnati, O. Meets, Second Tuesday. Honorary President, Capt. C. E. Hust. President, G. V. Sutfin, 1005-6 American Bldg., Cincinnati 2. Secretary, A. W. Edwards, 626 Broadway, Rm. 307, Cincinnati 2.

Connecticut: Organized, 1940. Headquarters, New Haven, Conn. President, L. A. Teasdale, 20 Ashmun St. Secretary, Winfield Roeder, 405 Temple St.

Delta: Organized, 1939. Headquarters, New Orleans, La. Meets, Second Tuesday. President, L. V. Cressy, 423 Baronne St., New Orleans 13. Secretary, J. S. Burke, 317 Baronne St., New Orleans 9.

Golden Gate: Organized, 1937. Headquarters, San Francisco, Calif. Meets, First Wednesday. President, C. L. Peterson, 2 Indian Rock Path, Berkeley. Secretary, James Gayner, 260 California St., San Francisco 11.

Illinois: Organized, 1906. Headquarters, Chicago, Ill. Meets, Second Monday. President, A. O. May, Room 925, 53 W. Jackson Blvd., Chicago 4. Secretary, C. M. Burnam, Jr., Room 1605, 6 N. Michigan Ave., Chicago 2.

Indiana: Organized, 1943. Headquarters, Indianapolis, Ind. Meets, Fourth Friday. President, W. C. Bevington, 730 Indiana Pythian Bldg. Secretary, C. W. Stewart, 1001 York St.

Iowa: Organized, 1940. Headquarters, Des Moines, Ia. Meets, Second Tuesday. President, W. W. Stuart, 417 9th St. Secretary, E. O. Olson, Iowa State College, Ames.

Kansas City: Organized, 1917. Headquarters, Kansas City, Mo. Meets, First Monday. President, D. M. Allen, 215 Pershing Rd., Kansas City 8. Secretary, R. E. Bade, 1102 Commerce Bldg.

Manitoba: Organized, 1935. Headquarters, Winnipeg, Man. Meets, Third Thursday. President, Einar Anderson, 152 Bannerman Ave. Secretary, F. T. Ball, 810 9th Ave., W., Calgary, Alta.

Massachusetts: Organized, 1912. Headquarters, Boston, Mass. Meets, Third Tuesday. President, D. M. Archer, 143 Federal St., Boston 10. Secretary, C. W. Larson, 184 Sycamore St., Roslindale.

Michigan: Organized, 1916. Headquarters, Detroit, Mich. Meets, First Monday after 10th of month. President, W. H. Old, 1761 Forest Ave. W., Detroit 8. Secretary, A. E. Knibb, 1003 Maryland Ave., Detroit 30.

Minnesota: Organized, 1918. Headquarters, Minneapolis, Minn. Meets, First Monday. President, F. W. Legler, 17 W. 28th St. Secretary, F. H. Schernbeck, 1057 10th Ave. S. E.

Montreal: Organized, 1936. Headquarters, Montreal, Que. Meets Third Monday. President, A. M. Peart, 637 Craig, W. Secretary, Leo Garneau, Room 832, Dominion Square Bldg.

Nebraska: Organized, 1940. Headquarters, Omaha. Meets, Second Tuesday. President, B. G. Peterson, 6235 Florence Blvd. Secretary, D. E. McCulley, 1101 Jackson St., Omaha 8.

New York: Organized, 1911. Headquarters, New York, N. Y. Meets, Third Monday. President, C. S. Koehler, 4374 Richardson Ave., New York 66. Secretary, Carl H. Flink, Room 3000, 51 Madison Ave., New York 10.

North Carolina: Organized, 1939. Headquarters, Durham, N. C. Meets, Quarterly. President, F. E. P. Klages, 1034 Jefferson Standard Bldg., Greensboro. Secretary, W. L. Hunken, 707 Guilford Bldg., Greensboro.

North Texas: Organized, 1938. Headquarters, Dallas, Tex. Meets, Third Monday. President, L. C. McClanahan, 603 Great National Life Bldg. Secretary, E. J. Stern, 701 Burt Bldg., Dallas 1.

Northern Ohio: Organized, 1916. Headquarters, Cleveland, O Meets, Second Monday. President, D. L. Taze, 1302 Swetland Bldg., Cleveland 15. Secretary, R. H. Cutting, 3795 Glenwood Rd., Cleveland Heights.

Oklahoma: Organized, 1935. Headquarters, Oklahoma City, Okla. Meets, Second Monday. President, E. T. P. Ellingson, 314 Savings Bldg., Oklahoma City 2. Secretary, G. T. Donceel, Oklahoma Natural Gas Co.

Ontario: Organized, 1922. Headquarters, Toronto, Ont. Meets, First Monday. President, A. S. Morgan, 156 Glenmanor Dr. Secretary, H. R. Roth, 57 Bloor St., W.

Oregon: Organized, 1939. Headquarters, Portland, Ore. Meets, Thursday after First Tuesday. President, E. C. Willey, Oregon State College, Corvallis. Secretary, G. H. Risley, 516 S. W. Oak St., Portland 4.

Pacific Northwest: Organized, 1928. Headquarters, Seattle, Wash. Meets, Second Tuesday. President, M. N. Musgrave, 2019 Third Ave., Seattle 1. Secretary, J. D. Sparks, 7331 W. Green Lake Way, Seattle 3.

Philadelphia: Organized, 1916. Headquarters, Philadelphia, Pa. Meets, Second Thursday. President, A. C. Caldwell, 550 So. 48th St., Philadelphia 43. Secretary, J. O. Kirkbride, Fourth and Locust Sts., Philadelphia 6.

Pittsburgh: Organized, 1919. Headquarters, Pittsburgh, Pa. Meets, Second Monday. President, T. F. Rockwell, Carnegie Institute of Technology, Schenley Park. Secretary, E. H. Riesmeyer, Jr., 231-33 Water St., Pittsburgh 22.

St. Louis: Organized, 1918. Headquarters, St. Louis, Mo. Meets, First Tuesday. President, G. B. Rodenheiser, 4431 Finney Ave., St. Louis 13. Secretary, B. L. Evans, 571 Stratford Ave., University City.

South Texas: Organized, 1938. Headquarters, Houston, Texas. Meets, Third Friday. President, A. F. Barnes, 602 Kirby Bldg., Houston 2. Secretary, B. P. Fisher, Box 92, Houston 1.

Southern California: Organized, 1930. Headquarters, Los Angeles, Calif. Meets, Second Wednesday. President, Leo Hungerford, 3485 Wonderview Pl., Los Angeles 28. Secretary, Arthur Theobald, 336 North Foothill Rd., Beverly Hills, Calif.

Washington, D. C.: Organized, 1935. Headquarters, Washington, D. C. Meets, Second Wednesday. President, J. W. Markert, 8506 Garfield St., Bethesda, Md. Secretary, A. S. Gates, Jr., 111 County Rd., Kensington, Md.

Western Michigan: Organized, 1931. Headquarters, Grand Rapids, Mich. Meets, Second Monday. President, H. D. Bratt, 2259 Stafford Ave., S. W., Grand Rapids 7. Secretary, Frank Harbin, Jr., 181 West 21st St., Holland.

Western New York: Organized, 1919. Headquarters, Buffalo, N. Y. Meets, Second Monday. President, S. W. Strouse, 493 Franklin St., Buffalo 2. Secretary, G. E. Adema, 39 W. Balcom St.

Wisconsin: Organized, 1922. Headquarters, Milwaukee, Wis. Meets, Third Monday. President, I. J. Haus, 3880 N. Richards St., Milwaukee 1. Secretary, M. W. Bishop, 231 W. Wisconsin Ave., Milwaukee 3.